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Investigate Of CIE (L*,A*,B*) And The Total Colour Difference "ΔE*" Value Of Different Banknote Papers (Egyptian 5 Pounds "EGP", Egyptian 10 Pounds "EGP", 1 Riyal "SAR", 5 Dirham "AED", 1 Dollar "U$", 5 Euro "€") Upon CMC Modification And Accelerated Ageing

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Abstract:

Banknote papers include an extensive range of security features that involve secure complex process such as watermark, security thread, micro printing,.....etc.

Security features are very important elements integrated into paper banknotes for facing counterfeiting as without the presence of security features within banknote papers how we can face the counterfeiting crime!

In the present paper, different banknote papers (Egyptian 5 pounds "EGP", Egyptian 10 pounds "EGP", 1 Riyal "SAR", 5 Dirham "AED", 1 Dolar "U$", 5 Euro "€") are coated by different concentrations and different layers of carboxymethyl cellulose (CMC). Accelerated ageing speeds the natural ageing process of paper by subjecting it to extreme conditions.

We performed accelerated ageing; thermal ageing at 140 °C for 2 hours and UV-radiation ageing with two different wavelengths (λ_1= 256 nm, λ_2 = 336 nm).

Change CIE (L, a*, b*) and the total colour difference (colour tolerance); ΔE* values were investigated before and after CMC coating.*

Change CIE (L, a*, b*) and the total colour difference (colour tolerance); ΔE* values were measured and calculated before and after accelerated ageing.*

The security features of banknote papers were examined through transmitted light, UV light and IR.

It can be concluded that the effectiveness of security features integrated into banknote papers are marvellous as the accelerated ageing have no effect even small on the security features after CMC modification which reflects in increasing banknote papers durability.

Keywords: *Banknote papers, Security features, CIE (L*, a*, b*), The total colour difference (Colour tolerance) "ΔE ", Accelerated ageing, CMC.*

1.Introduction

1.1. Banknote Papers

Money is not only the foundation of the national economy, but also the mark of the national sovereignty and its mirrors the state which issues it. The symbolic role of money is one of its essential characteristics, and the name of the currency its salient feature [1]. National identity is a complex and intangible phenomenon, that is remarkably, difficult to define with any precision. Despite considerable research by geographers on the complex relationships between people, identity and nation **[2, 3]**, it is some what surprising that they have as yet paid rather little attention to direct empirical trails of national identity, such as postage stamps, place names **[4],** to explore the significance of the last of these, banknotes, in the context of the national identities that have emerged over the last decade all over the world.

The study aims to present an overview of the imagery reflected by these banknotes, together a very preliminary consideration of what this reveals about the shaping of national identities. They widely varying political and social processes that gave rise to the images depicted on the banknotes, as well as the narratives that each country has chosen to portray their national identities, remain the topics for future publications.

Water-soluble cellulose derivatives are a class of technically important compounds such as CMC (Na – Carboxymethyl cellulose) used for paper coating through LbL (layer-by-layer) composite. Hence, the objectives of this study are to investigate several optical properties of film-coating properties of the paper samples and compared with the original paper samples.

The evaluation of the state of conservation of aged paper artifacts in relation to the original paper is currently a prime issue in the cultural heritage field. The concern is essentially to collection managers but remains nonetheless a real change for the conservation physical chemist. Our important research objective that would help in designing preservation strategies by the characterization of the long-term chemical and physical stability of paper based collections. Moreover the ageing sub-products can be found in the paper after period of time and these substances mostly depend on the environmental conditions to which it has been subjected. Hence, paper coating play an essential role in paper protection thus research dedicated to the identification and optimization of procedures to be employed in paper conservation is concentrated on acquiring a clear understanding of optical and physical properties of paper

samples. So we performed accelerated aging either by thermal aging at 140°C & UV-radiation by two different wavelength (λ_1 = 256, λ_2= 336 nm).

1.2.Evaluation And Specification Of Paper's Colour

The paper has striked the subject of different wavelengths, and optical characteristics have been described in terms of monochromatic light, or as an approximation, by treating white light as a single entity. White light is composed of many wavelengths. Because the refractive index values of most materials change significantly as a function of wavelength, it is not strictly accurate to apply analyses to white light. In addition, any description of paper's appearance without considering its colour cannot be complete. Fortunately, some of the sample principles already outlined can be extended across the whole visible spectrum. In order to start the analysis. It is first necessary to give a mathematical interpretation of human vision. Although colour information can be specified in an unambiguous manner either with X, Y and Z values or with x and y values, colour scientists have put a lot of effort into trying to find a way to express colours such as the numerical differences in colour can give an indication of how.

Similar or different two different colours appear to an average viewer. For instance, in the coordinate system defined by the chromaticity coordinates X and Y, a large amount of the plot is devoted to shades of green, whereas colours such as orange and blue are crowded into narrower segments of the plot. Although there are several such systems in current use, one of the most commonly used in the CIE L*, a*, b* system[5]. Figure 1 illustrate the L* - a* - b* coordinate system.

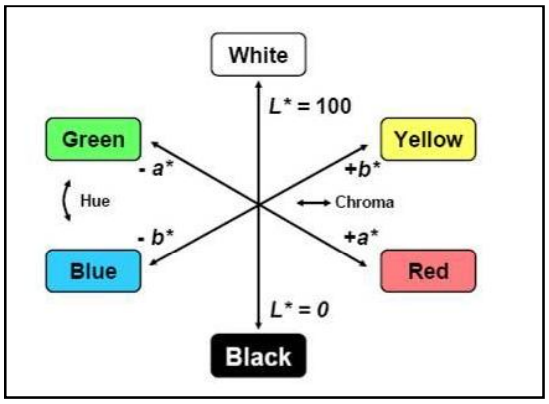

Figure 1: Coordinate system for L'-a-b* color space*

The parameter L*, which is often called the "light-ness" of the sample, can be taken as a measure of the sample's reflectance in the mid-range of visible spectrum. Likewise, a* can be taken as a measure of the redness (positive values of a*) versus green-ness (negative values of a*) and b* can be taken as a measure of the yellowness (positive values of b*) versus blueness (negative values of b*).

1.3.Colour Tolerance

Color technologists have spent considerable effort to develop single-valued criteria by which to accept or reject coloured products, in terms of how closely they match to a selected standard colour.

Within the CIE L*, a*, b* system, a colour tolerance value (the total colour difference value) can be calculated as follows **[6-8]**,

$\Delta E = [(L_1^* - L_2^*)^2 + (a_1^* - a_2^*)^2 + (b_1^* - b_2^*)^2]^{0.5}$

where the subscript 1 refers to the sample data and subscript 2 refers the standard [9-12].

1.4.Security Features

Paper security [13] may be achieved by the addition of certain products to the paper during its manufacture. A review on security papers is given in reference [14]. Banknote security features (Figure 2) (paper embedded features) aimed at raising counterfeit resistance. In order to raise threshold against forgery (alteration) [15], chemicals may also be added to the paper that serve as an indicator of chemical and solvent attack like CMC, for example, in our case.

Figure 1: Security Features

Most of banknotes are made of heavy paper, almost always from cotton fibers for strength and durability, in some cases linen or specialty coloured or forensic fibers are added to give the paper added individuality and protect against counterfeiting (Figure 3-9) [16].

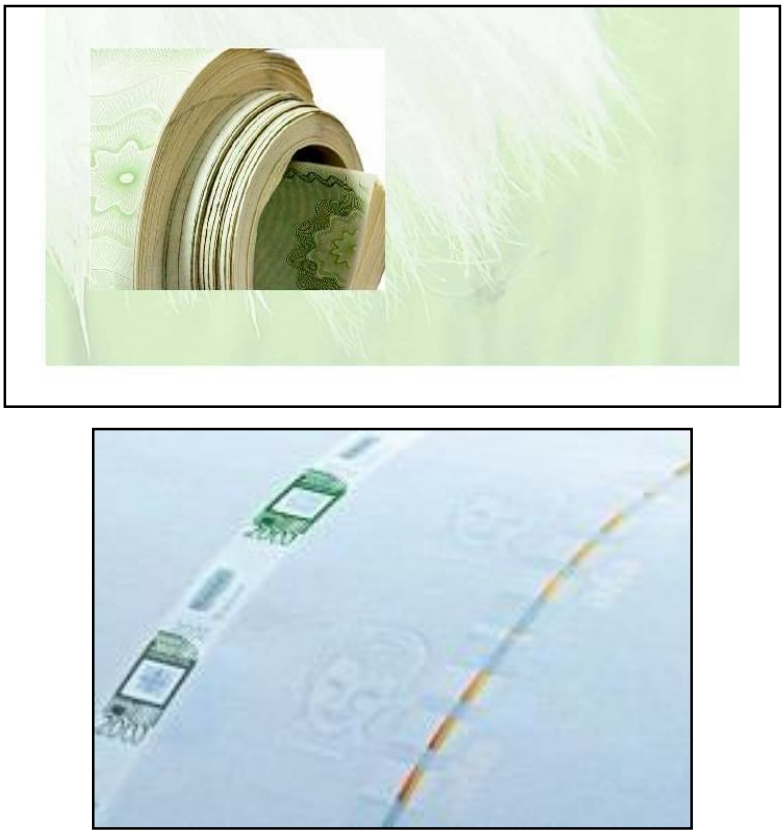

Figure 3: Paper substrate

Figure 4: Visible Fiber

Figure 5: Intaglio Printing

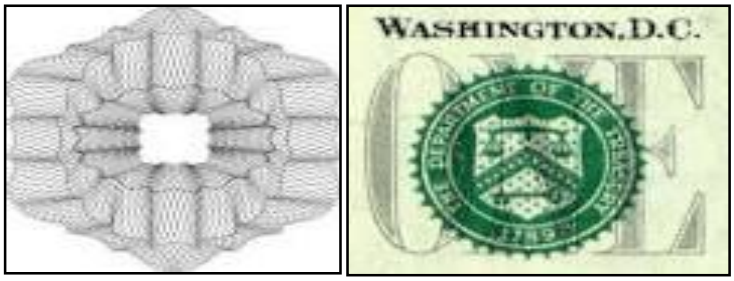

Figure6: Geometric lathe work

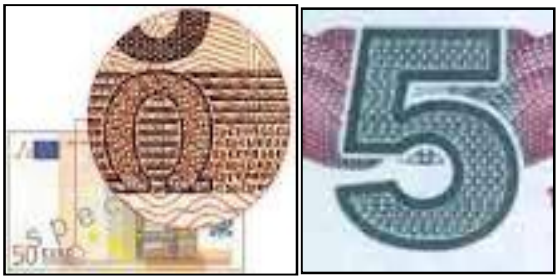

Figure 7: Microprinting

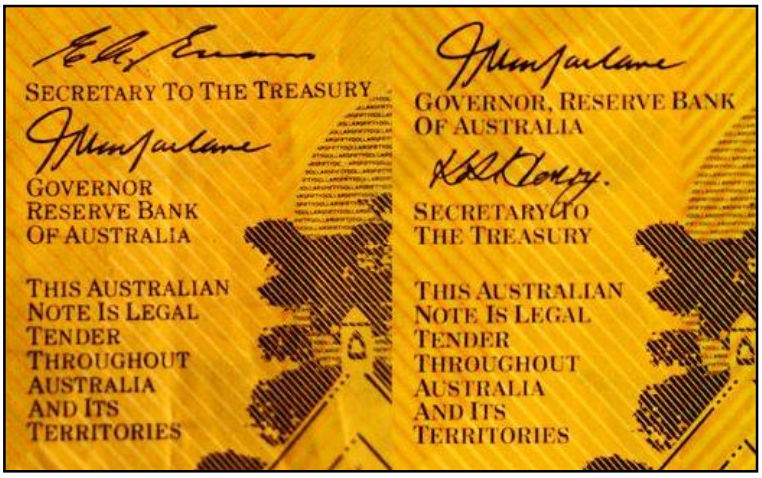

Figure 8: Microprint signature line

Figure 9: Watermark

2.Experimental

2.1.Banknote Papers

The banknote papers used in this work are Egyptian 5 pounds "EGP", 1 Riyal "SAR", 5 Dirham "AED", 5 Euro "E" and 1 Dollar "US" are printed in year (2009 & 2010), (2009 & 2010), (2007 & 2009), (2007), (2002), (2003 & 2006 & 2009) series, respectively.

2.2.Used Chemical

2.2.1.Sodium Carboxymethyl Cellulose (CMC)

Sodium carboxymethyl cellulose[17-19] used for coating of Xerox paper sheets and Banknote papers was supplied by Adwic (El Nasr Pharmaceutical Chemicals Co.). It

was without further treatment. Carboxymethyl cellulose **(Figure 1)** [20-44] is a white powder (NMT 10%) with a degree of substitution 0.6 – 0.85, the viscosity of 4% of dry substance in water is 20-50mpas, loss on drying at 110ºC and PH of 2% solution 6-8 **[25], [26], [27].**

2.3.Thermal Ageing (Gallenhamp BS Oven)

The paper samples were exposed to heat up to 140ºC for 2 hours in National Research Center (NRC) using Gallenhamp BS oven; size one, Germany.

2.4.UV-radiation (UV-lamp or UV-cabinet MODEL UVGL-25)

The paper samples were exposed to short wavelength of UV-radiation (λ_1 = 256 nm) and long wavelength of UV-radiation (λ_2 =336) for 30 hours in Minia University using UV-Lamp or UV-Cabinent MODEL UVGL-25 MINERALIGHT LAMP UV-256 / 336 NM, 2-250 volts, 50/60 HZ UVP, Upland, CA 91786, U.S.A.

*2.5.CIE L*a*b* (Commission International d' Eclairage) (Colour Meter, Gretag Macbeth™ SpectroEye™)*

The colour changes of paper samples were measured using Colour Meter; GretagMacbeth™ SpectroEye™, WGG60, Pushen, U.S.A. **(Figure 10)**

*Figure 10: CIE L*a*b* (Commission International d'Eclairage) (Colour Meter, Gretag Macbeth™ SpectroEye™)*

2.6.Security Features of different Banknote papers (through transmitted light , UV and IR)

The photos of different banknote papers (Egyptian 5 pounds "EGP", Egyptian 10 pounds "EGP", 1 Riyal "SAR", 5 Dirham "AED", 5 Euro "E", 1 Dollar "US" before and after coating by carboxymethyl cellulose (CMC) and also before and after ageing either by thermal ageing or UV-radiation ageing were obtained by SONY-CORP,

DSC-W560, DIGITAL STILL CAMERA, 14.1; Carl Zeiss-Vario-Trassar (2.7-5.7 / 4.7-18.8), 3.6 V (6890501).

2.7.Security features of different banknote papers through transmitted light , UV-light and IR (VSC® 6000 "video spectral comparator for questioned document examination" foster + freeman)

The photos of different banknote papers (Egyptian 5 pounds "EGP", Egyptian 10 pounds "EGP", 1 Riyal "SAR", 5 Dirham "AED", 1 Dollar "U$", Euro "€" before and after coating by carboxymethyl cellulose (CMC) (the 3rd of 0.1 % and 1% conc. and also before and after ageing either by thermal ageing and UV- radiation ageing) through transmitted light and also (the 3rd layer of 1 % conc. and also before and after ageing either by thermal ageing or UV-radiation ageing) through UV-light and IR were taken via VSC® 6000,respectively. The examination were carried out in the Ministry of Justice, Cairo. VSC 6000 features include: "HFi" technology for improved image quality, 30" (75 cm) wide screen monitor for improved image display, on-screen magnification up to x 170 (+/- 6%), field of view from approximately 2.5 x 1.9 mm to 210 x 160 mm, full range of light source including transmitted light ,UV-light and IR and connected to Hp color laser jet printer (4700 dn) – color sphere Hp toners, foster + freeman Ltd. Vale Park, Evesham, Vorcestershire, WR111 TD, United Kingdom, England (Figure 11).

Figure 11: (VSC® 6000 "video spectral comparator for questioned document examination" foster + freeman).

2.7.1.Sodium carboxymethyl cellulose (CMC)

Sodium carboxymethyl cellulose[17-19] used for coating of Xerox paper sheets and Banknote papers was supplied by Adwic (El Nasr Pharmaceutical Chemicals Co.). It was without further treatment. Carboxymethyl cellulose (Figure 1) [20-44] is a white powder (NMT 10%) with a degree of substitution 0.6 – 0.85, the viscosity of 4% of dry substance in water is 20-50mpas, loss on drying at 110ºC and PH of 2% solution 6-8 [25], [26], [27].

2.8. Method For The Evaluation Of Paper Properties

2.8.1.CIE L*a*b*

Colour is field among the optical properties f paper and can be measured according to the standards TAPPI T524 [28], TAPPI527 [29] ISO13655 [131] and ISO 12647-2 [132].

Lately, the L*,a* and b* coordinates of the three dimensional CIEL*a*b*. Commission International d' Eclairage) (1976) colour space [30] have been introduced [31-33] and gradually started to replace the "traditionally" used [34-39] optical parameter "brightness" in paper conservation evaluation (Figure 12) [36,37].

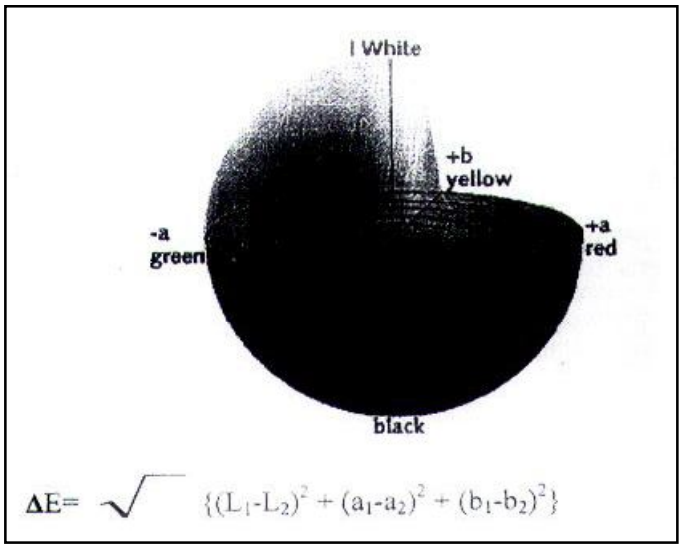

*Figure 12: CIE L*a*b**

(L*, a*, b*) is the best neutral way ISO certified to measure colours, colour space in which values L*, a* and b* are plotted at right angles to one another to form a three-

dimensional coordinate system. Equal distances in the space approximately represent equal colour differences, where the polar coordinates (L*) represents lightness (0-100%); (a*) represents colour coordinate (X) (Position in the Red-green axis); (b*) represents coordinate (Y) (position in the yellow-blue axis) are vectors which are normal to each other (to determine the colours position in the Lab Colour Space).

The total colour difference ΔE* between two paper samples was calculated by the following equation [38]:

$$\Delta E^* = \sqrt{(\Delta L^*)^2 + (\Delta a^*)^2 + (\Delta b^*)^2}$$

where $\Delta L^* = L^*(t) - L^*(0)$; $\Delta a^* = a^*(t) - a^*(0)$; $\Delta b^* = b^*(t) - b^*(0)$

are the differences calculated for aged paper samples and the original paper samples (0).

2. 9. Paper Coating (Dipping Technique)

The paper samples, Banknote papers were dipped in different concentration and multilayers of carboxymethyl cellulose (CMC) solutions (0.1, 1%) for one min. After dipping, the paper samples were pressed between two filter sheets to remove the excess polymer, and then left to dry in air [39, 40], [41, 42], [43], [44].

2.10. Thermal Ageing Of Paper Samples

Paper samples are heated in an oven at temperature (140ºC) for 2 hours as per ASTM standard D 2304-91 [40-123], [124].

2.11. UV-Radiation Ageing Of Paper Samples

Paper samples (Xerox paper sheets and Banknote papers) are exposed to UV-radiation (short wavelength; λ_1 = 256nm and long wavelength; λ_2 = 336 nm) using UV-lamp or UV-cabinet for 30 hours [125], [126-130], [130-135], [136-138], [139-160], [44 – 173].

2.12. Examination Of Effectiveness Of Security Features Of Different Banknote Paper Samples Through Transmitted Light And Through UV-Light And IR Via VSC® 6000 (Video Spectral Comparator For Questioned Document Examination):

Security features are very essential tools to face counterfeiting crime. The effectiveness of different Banknote papers (Egyptian 5 pounds "EGP", Egyptian 10 pounds "EGP", 1 Riyal "SAR", 5 Dirham "AED", 5 Euro "€", 1 Dollar "U$") before and after coating by carboxymethyl cellulose (CMC) and also before and after ageing either by thermal ageing or UV-radiation ageing through transmitted light, UV-light and IR. The photos were captured.

3. Results & Discussion

3.1.Optical elements (Brightness, CIE (L, a*, b*) values and Δ E*; total colour difference value or tolerance value)*

Paper samples properties were measured from the respective paper samples to enable a comparison with the original paper samples (reference paper samples) and also the previous studies related to that topic. It was found that the optical properties were slightly decreased as a result of CMC modification (coating) of paper samples. The optical properties; brightness values and CIE (L*, a*, b*) and Δ E* values are listed in (Table 1 to 21). However, the effects of CMC modification was not as strong as that of refining. Moreover, in a study by Watanabe et al., brightness slightly decreases by CMC coating and the formation of layer-by-layer (LbL) composite because of the improved retention of CMC while (L*, a*, b*) values increase because of the effects of different multicoating by different coating materials; Dyes and pigments other than CMC beside the marvelous refining of paper pulp of different Banknote paper used. CMC coating and LbL composite leads to increase in density which implies sheet consolidation which in turn had a rather effect on light scattering coefficient. Usually, strength agents do not affect light scattering much because of an increase in CMC quenching excited carbonyl chromophores of compound species. The formation of a complex between excited species which collapses to new products can not be excluded, although no product which could be assigned to such a collapse was identified. Oxyradicals, especially peroxyl radicals have recently been recognized as important elements in yellowing. Scavenging of peroxyl radicals by CMC coating [174].

Thus "such scavenging action seems to be justified in the inhibition mechanism. Scavenging of phO, which is less reactive due to resonance stabilization of the radical can not be ruled out. A slow reaction of phenoxy radicals has been invoked by CMC coating of paper samples. In discussing the probabilities of the product formation O-quinones may be formed from phO, it is worth emphasizing that many phenoxy radicals absorb light from 300nm to the visible region [124]. Once excited by UV-radiation, phenoxy radicals may undergo reactions not possible in thermal ageing conditions. In the presence of low concentration of CMC, the reaction pathways of excited phO could be altered, leading instead to non-quinone, non-coloured products. It could be assumed that the products formed in side reactions responsible for yellowing through absorption could be unsaturated compounds deriving from the opening of several cyclic cellulose units and the products responsible for yellowing through absorption were rigid structure due to the specific bond strength rather than bonded area. The high concentration of CMC under accelerated ageing; either thermal ageing or UV-radiation ageing potentially decrease the surface quality of the optical elements. By appling accelerated ageing; either thermal ageing (high temperature) and UV-radiation ageing (UV light) on paper samples coated by high concentration of CMC leads to induced optical elements. As the degree of the optical element decreasing upon accelerated ageing is dependent on the material composition [176-180].

Yellowing through thermal ageing and UV-radiation., in the case of very high concentration of CMC is caused by the presence of groups with rigid structures as observed in ligneous residues of cellulose.

Upon thermal ageing, different oxidation mechanisms of cellulose were proposed successively by Daruwalla et al. [181] and by Feller et al. [182] differing essentially in the primary oxidized sites in addition to the observed chain scissions upon UV-radiation ageing, the fluorescence is a slow deactivation process of excited states exhibiting a long time (10-85s). The excited fluorescent states are then able to react with atmospheric oxygen to be oxidized into coloured or colourless product. The fluorescent groups formed by oxidation of organic matter can not accumulate and are able to initiate oxidation of organic environment.

That is why the more the concentration of CMC increased used for paper sample coating and the more the number of CMC coating layer increased after accelerated ageing, the more the optical elements decrease; brightness, (L*, a*, b*) and Δ E*; the

total colour difference or colour tolerance [183-184]. Δ E* varies according to the changes in a* (location on the red-green axis) and b* (location on the yellow-blue axis). The data of optical elements are listed in (Table 1 to 21) and are illustrated in (Figure 13 to 117). The high positive value of b* indicates that the paper is much yellower, according to the standard. The reason for this is chemical degradation of hemicellulose components in the fibers as part of the ageing process. The yellowness of the lignin fibers in the paper samples is much higher [185-188].

That indicates that low surface roughness of paper samples translates into reduced scattering of light "UV-radiation" at optical surfaces.

The different optical parameters Δ L*, Δ a*, Δ b* and Δ E* are represented graphically against concentration plus a* parameter (location on the red-green axis) is represented graphically against b* parameter (location on the yellow-blue axis) to observe the change of colour after CMC modification, LbL composite and before and after accelerated ageing which are all represented in (Figure 13 to Figure 117) from all the previous mentioned figures, we observe that there is no significant change of colour of all paper samples after CMC coating and even after accelerated ageing (thermal and UV-radiation ageing).

Blank of 5 Euro without any treatment: L*= 129.80 a* = -10.94 b* = -8.56
Blank of 5 Euro after thermal ageing at 140 0^C : L*= 120.12 a* = 17.39 b* = -16.78
Blank of 5 Euro after UV radiation ageing (λ_1 = 256 nm): L*= 126.97 a* = 0.85 b* = -5.25
Blank of 5 Euro after UV radiation ageing (λ_2 = 336 nm): L*= 122.05 a* = 10.06 b* = -9.61

Treatment	**L***	**a***	**b***	**ΔE***
Coating	138.12	27.39	-16.78	40.07
Thermal ageing at 140 ^{0}C	133.30	17.69	-35.98	23.29
UV radiation ageing (λ_1 = 256 nm)	128.41	-17.97	-27.69	29.32
UV radiation ageing (λ_2 = 336 nm)	125.86	-13.47	0.86	26.03

Table 1: (L, a*, b*) values of banknote paper (5 Euro "€") coated by 3rd L of (1%) Carboxymethyl cellulose (CMC) before and after ageing either by thermal ageing at 140 ^{0}C or by UV radiation (λ_1= 256 nm, λ_2 = 336 nm).*

Blank of 5 Dirham without any treatment: L*= 120.35 a* = 12.65 b* = -6.75
Blank of 5 Dirham after thermal ageing at 140 0^C : L*= 112.00 a* = 1.83 b* =-8.74
Blank of 5 Dirham after UV radiation ageing (λ_1 = 256 nm): L*= 118.56 a* = 5.62 b* = 9.47
Blank of 5 Dirham after UV radiation ageing (λ_2 = 336 nm): L*= 115.52 a* = 7.04 b* = 12.88

Treatment	**L***	**a***	**b***	**ΔE***
Coating	129.07	15.00	-5.56	9.11
Thermal ageing at 140 ^{0}C	123.39	20.73	-17.41	23.71
UV radiation ageing (λ_1 = 256 nm)	125.49	-18.58	3.50	137.44
UV radiation ageing (λ_2 = 336 nm)	124.39	11.60	-6.85	106.15

Table (2): (L, a*, b*) values of banknote paper (5 Dirham "AED") coated by 3rd L of (1%) Carboxymethyl cellulose (CMC) before and after ageing either by thermal ageing at 140 ^{0}C or by UV radiation (λ_1= 256 nm, λ_2 = 336 nm).*

Blank of 5 Riyals without any treatment: L*= 121.15 a* = 0.72 b* = -8.10
Blank of 5 Riyals after thermal ageing at 140 0^C : L*= 113.98 a* = 14.24 b* =-19.08
Blank of 5 Riyals after UV radiation ageing (λ_1 = 256 nm): L*= 120.10 a* =14.11 b* = 6.00
Blank of 5 Riyals after UV radiation ageing (λ_2 = 336 nm): L*= 118.87 a* = 11.58 b* = 41.97

Treatment	**L***	**a***	**b***	**ΔE***
Coating	126.63	-4.43	-8.05	7.52
Thermal ageing at 140 ^{0}C	118.92	0.82	4.96	27.97
UV radiation ageing (λ_1 = 256 nm)	122.80	-33.39	17.81	49.02
UV radiation ageing (λ_2 = 336 nm)	120.94	-0.22	10.75	33.44

Table 3: (L, a*, b*) values of banknote paper (5 Riyals "SAR") coated by 3rd L of (1%) Carboxymethyl cellulose (CMC) before and after ageing either by thermal ageing at 140 ^{0}C or by UV radiation (λ_1= 256 nm, λ_2 = 336 nm)*

Blank of Egyptian 5 pounds without any treatment: L*= 110.48 a* = -9.85 b* = 8.84
Blank of Egyptian 5 pounds after thermal ageing at 140 0^C : L*= 100.10 a* = 38.45 b* =2.17
Blank of Egyptian 5 pounds after UV radiation ageing (λ_1 = 256 nm): L*= 108.62 a* =1.85 b* =-32.25
Blank of Egyptian 5 pounds after UV radiation ageing (λ_2 = 336 nm): L*= 108.62 a* = 34.61 b* = -18.31

Treatment	**L***	**a***	**b***	**ΔE***
Coating	112.83	-21.90	6.66	12.47
Thermal ageing at 140 ^{0}C	102.43	50.58	-17.02	22.82
UV radiation ageing (λ_1 = 256 nm)	109.48	-9.12	0.01	34.09
UV radiation ageing (λ_2 = 336 nm)	104.72	5.48	-25.89	30.35

Table (4): (L, a*, b*) values of banknote paper (Egyptian 5 pounds "EGP") coated by 1st L of (0.1%) Carboxymethyl cellulose (CMC) before and after ageing either by thermal ageing at 140 ^{0}C or by UV radiation (λ_1= 256 nm, λ_2 = 336 nm).*

Treatment	**L***	**a***	**b***	**ΔE***
Coating	114.69	39.00	-6.42	51.35
Thermal ageing at 140 ^{0}C	103.83	-7.90	-22.34	52.56
UV radiation ageing (λ_1 = 256 nm)	110.62	10.28	-3.30	30.22
UV radiation ageing (λ_2 = 336 nm)	107.56	-24.72	-5.23	60.76

Table 5: (L, a*, b*) values of banknote paper (Egyptian 5 pounds "EGP") coated by 1st L of (1%) Carboxymethyl cellulose (CMC) before and after ageing either by thermal ageing at 140 ^{0}C or by UV radiation (λ_1= 256 nm, λ_2 = 336 nm)*

Treatment	L*	a*	b*	ΔE*
Coating	117.53	11.89	16.39	24.07
Thermal ageing at 140 ^{0}C	105.00	15.69	19.97	29.31
UV radiation ageing (λ_1 = 256 nm)	112.20	-20.51	-6.80	34.07
UV radiation ageing (λ_2 = 336 nm)	110.44	-12.90	9.99	55.33

Table 6: (L, a*, b*) values of banknote paper (Egyptian 5 pounds "EGP") coated by 2nd L of (0.1%) Carboxymethyl cellulose (CMC) before and after ageing either by thermal ageing at 140 ^{0}C or by UV radiation (λ_1= 256 nm, λ_2 = 336 nm)*

Treatment	L*	a*	b*	ΔE*
Coating	120.25	-23.38	-0.30	19.03
Thermal ageing at 140 ^{0}C	106.97	38.07	-5.22	10.10
UV radiation ageing (λ_1 = 256 nm)	115.93	-33.78	-0.25	48.45
UV radiation ageing (λ_2 = 336 nm)	112.51	-15.77	6.93	56.48

Table 7:(L, a*, b*) values of banknote paper (Egyptian 5 pounds "EGP") coated by 2nd L of (1%) Carboxymethyl cellulose (CMC) before and after ageing either by thermal ageing at 140 ^{0}C or by UV radiation (λ_1= 256 nm, λ_2 = 336 nm)*

Treatment	L*	a*	b*	ΔE*
Coating	122.56	6.96	13.25	21.16
Thermal ageing at 140 ^{0}C	108.52	-19.32	-41.68	73.01
UV radiation ageing (λ_1 = 256 nm)	118.29	38.07	-5.22	46.22
UV radiation ageing (λ_2 = 336 nm)	115.05	11.12	-10.56	25.56

Table 8: (L, a*, b*) values of banknote paper (Egyptian 5 pounds "EGP") coated by 3rd L of (0.1%) Carboxymethyl cellulose (CMC) before and after ageing either by thermal ageing at 140 ^{0}C or by UV radiation (λ_1= 256 nm, λ_2 = 336 nm).*

Treatment	**L***	**a***	**b***	**ΔE***
Coating	125.74	21.94	-6.84	38.59
Thermal ageing at 140 ^{0}C	110.05	32.31	-13.53	19.58
UV radiation ageing (λ_1 = 256 nm)	120.75	-29.49	42.75	82.18
UV radiation ageing (λ_2 = 336 nm)	116.74	21.94	-6.84	18.92

Table 9: (L, a*, b*) values of banknote paper (Egyptian 5 pounds "EGP") coated by 3rd L of (1%) Carboxymethyl cellulose (CMC) before and after ageing either by thermal ageing at 140 ^{0}C or by UV radiation (λ_1= 256 nm, λ_2 = 336 nm)*

Blank of Egyptian 10 pounds without any treatment: L*= 115.69 a* = -27.81 b* = -7.65
Blank of Egyptian 10 pounds after thermal ageing at 140 0^C : L*= 105.80 a* = 35.08 b* =-31.88
Blank of Egyptian 10 pounds after UV radiation ageing (λ_1 = 256 nm): L*= 112.30 a* =27.52 b* =0.03
Blank of Egyptian 10 pounds after UV radiation ageing (λ_2 = 336 nm): L*= 110.25 a* = -21.33 b* = 27.82

Treatment	L*	a*	b*	ΔE*
Coating	116.24	-21.33	27.82	36.06
Thermal ageing at 140 ^{0}C	108.26	-12.20	-20.08	48.79
UV radiation ageing (λ_1 = 256 nm)	115.16	8.25	2.64	19.66
UV radiation ageing (λ_2 = 336 nm)	112.43	-30.23	2.70	26.74

Table 10:(L, a*, b*) values of banknote paper (Egyptian 10 pounds "EGP") coated by 1st L of (0.1%) Carboxymethyl cellulose (CMC) before and after ageing either by thermal ageing at 140 ^{0}C or by UV radiation (λ_1= 256 nm, λ_2 = 336 nm).*

Treatment	L*	a*	b*	ΔE*
Coating	118.89	-16.92	43.24	52.14
Thermal ageing at 140 ^{0}C	110.55	16.58	-17.47	23.93
UV radiation ageing (λ_1 = 256 nm)	116.05	-9.86	19.24	42.19
UV radiation ageing (λ_2 = 336 nm)	115.68	-12.38	18.50	14.02

Table 11: (L, a*, b*) values of banknote paper (Egyptian 10 pounds "EGP") coated by 1st L of (1%) Carboxymethyl cellulose (CMC) before and after ageing either by thermal ageing at 140 ^{0}C or by UV radiation (λ_1= 256 nm, λ_2 = 336 nm).Table (11): (L*, a*, b*) values of banknote paper (Egyptian 10 pounds "EGP") coated by 1st L of (1%) Carboxymethyl cellulose (CMC) before and after ageing either by thermal ageing at 140 ^{0}C or by UV radiation (λ_1= 256 nm, λ_2 = 336 nm).*

Treatment	L*	a*	b*	ΔE*
Coating	121.43	-3.77	18.33	35.86
Thermal ageing at 140 ^{0}C	113.11	-5.30	4.48	54.83
UV radiation ageing (λ_1 = 256 nm)	119.34	17.80	10.89	16.19
UV radiation ageing (λ_2 = 336 nm)	116.87	15.54	44.38	40.96

Table (12): (L, a*, b*) values of banknote paper (Egyptian 10 pounds "EGP") coated by 2nd L of (0.1%) Carboxymethyl cellulose (CMC) before and after ageing either by thermal ageing at 140 ^{0}C or by UV radiation (λ_1= 256 nm, λ_2 = 336 nm)*

Treatment	L*	a*	b*	ΔE*
Coating	123.31	8.23	-10.94	36.98
Thermal ageing at 140 ^{0}C	115.03	7.82	-13.63	34.08
UV radiation ageing (λ_1 = 256 nm)	120.84	22.43	-19.61	22.01
UV radiation ageing (λ_2 = 336 nm)	118.82	33.51	-12.60	68.66

Table (13): (L, a*, b*) values of banknote paper (Egyptian 10 pounds "EGP") coated by 2nd L of (1%) Carboxymethyl cellulose (CMC) before and after ageing either by thermal ageing at 140 ^{0}C or by UV radiation (λ_1= 256 nm, λ_2 = 336 nm).*

Treatment	L*	a*	b*	ΔE*
Coating	125.34	-15.54	44.38	54.32
Thermal ageing at 140 ^{0}C	116.11	-5.30	4.48	55.31
UV radiation ageing (λ_1 = 256 nm)	123.34	17.80	10.89	18.28
UV radiation ageing (λ_2 = 336 nm)	120.78	-3.77	18.33	22.57

Table 14: (L, a*, b*) values of banknote paper (Egyptian 10 pounds "EGP") coated by 3rd L of (0.1%) Carboxymethyl cellulose (CMC) before and after ageing either by thermal ageing at 140 ^{0}C or by UV radiation (λ_1= 256 nm, λ_2 = 336 nm)*

Treatment	L*	a*	b*	ΔE*
Coating	128.31	8.23	-10.94	38.33
Thermal ageing at 140 ^{0}C	118.93	7.82	-13.63	35.34
UV radiation ageing (λ_1 = 256 nm)	125.84	22.43	-19.61	24.39
UV radiation ageing (λ_2 = 336 nm)	122.82	33.51	-12.60	69.28

Table (15): (L, a*, b*) values of banknote paper (Egyptian 10 pounds "EGP") coated by 3rd L of (1%) Carboxymethyl cellulose (CMC) before and after ageing either by thermal ageing at 140 ^{0}C or by UV radiation (λ_1= 256 nm, λ_2 = 336 nm)*

Blank of 1 Dollar without any treatment: L*= 131.35 a* = -36.02 b* = 18.16
Blank of 1 Dollar after thermal ageing at 140 0^C : L*= 122.27 a* = 25.25 b* =8.97
Blank of 1 Dollar after UV radiation ageing (λ_1 = 256 nm): L*= 128.33 a* =16.76 b* =-11.69
Blank of 1 Dollar after UV radiation ageing (λ_2 = 336 nm): L*= 125.11 a* = 8.64 b* = 31.44

Treatment	L*	a*	b*	ΔE*
Coating	133.50	29.95	22.87	66.17
Thermal ageing at 140 ^{0}C	125.97	-6.85	2.38	32.98
UV radiation ageing (λ_1 = 256 nm)	130.88	15.47	1.37	13.37
UV radiation ageing (λ_2 = 336 nm)	127.22	29.95	22.87	23.07

Table (16): (L, a*, b*) values of banknote paper (1 Dollar "U$") coated by 1st L of (0.1%) Carboxymethyl cellulose (CMC) before and after ageing either by thermal ageing at 140 ^{0}C or by UV radiation (λ_1= 256 nm, λ_2 = 336 nm).*

Treatment	L*	a*	b*	ΔE*
Coating	135.61	-16.29	38.40	28.58
Thermal ageing at 140 ^{0}C	126.97	5.63	-15.00	31.33
UV radiation ageing (λ_1 = 256 nm)	131.55	-29.45	-13.78	46.37
UV radiation ageing (λ_2 = 336 nm)	129.52	27.80	9.60	29.39

Table 17: (L, a*, b*) values of banknote paper (1 Dollar "U$") coated by 1st L of (1%) Carboxymethyl cellulose (CMC) before and after ageing either by thermal ageing at 140 ^{0}C or by UV radiation (λ_1= 256 nm, λ_2 = 336 nm).*

Treatment	L*	a*	b*	ΔE*
Coating	136.22	20.00	21.92	56.36
Thermal ageing at 140 ^{0}C	128.51	2.49	-43.09	57.16
UV radiation ageing (λ_1 = 256 nm)	130.17	42.49	-21.86	27.73
UV radiation ageing (λ_2 = 336 nm)	133.03	15.92	4.97	28.57

Table 18: (L, a*, b*) values of banknote paper (1 Dollar "U$") coated by 2nd L of (0.1%) Carboxymethyl cellulose (CMC) before and after ageing either by thermal ageing at 140 ^{0}C or by UV radiation (λ_1= 256 nm, λ_2 = 336 nm).*

Treatment	L*	a*	b*	ΔE*
Coating	138.00	21.28	-5.30	62.27
Thermal ageing at 140 ^{0}C	130.02	-11.77	21.52	39.85
UV radiation ageing (λ_1 = 256 nm)	135.57	6.45	-1.75	16.05
UV radiation ageing (λ_2 = 336 nm)	131.52	-24.87	-21.58	63.05

Table 19: (L, a*, b*) values of banknote paper (1 Dollar "U$") coated by 2nd L of (1%) Carboxymethyl cellulose (CMC) before and after ageing either by thermal ageing at 140 ^{0}C or by UV radiation (λ_1= 256 nm, λ_2 = 336 nm)*

Treatment	L*	a*	b*	ΔE*
Coating	139.77	-21.08	26.28	18.97
Thermal ageing at 140 ^{0}C	131.52	-21.76	-6.85	50.46
UV radiation ageing (λ_1 = 256 nm)	136.46	-6.35	-17.77	25.24
UV radiation ageing (λ_2 = 336 nm)	133.71	17.27	25.60	13.51

Table 20: (L, a*, b*) values of banknote paper (1 Dollar "U$") coated by 3rd L of (0.1%) Carboxymethyl cellulose (CMC) before and after ageing either by thermal ageing at 140 ^{0}C or by UV radiation (λ_1= 256 nm, λ_2 = 336 nm).*

Treatment	L*	a*	b*	ΔE*
Coating	142.36	32.21	-2.98	72.27
Thermal ageing at 140 ^{0}C	133.08	30.46	-48.50	58.71
UV radiation ageing (λ_1 = 256 nm)	135.52	2.43	-27.18	22.29
UV radiation ageing (λ_2 = 336 nm)	138.42	2.32	-9.67	43.67

Table (21): (L, a*, b*) values of banknote paper (1 Dollar "U$") coated by 3rd L of (1%) Carboxymethyl cellulose (CMC) before and after ageing either by thermal ageing at 140 ^{0}C or by UV radiation (λ_1= 256 nm, λ_2 = 336 nm)*

3.2.Effectiveness Of Security Features Of Different Banknote Papers After CMC Coating And Accelerated Ageing; Thermal And UV-Radiation Ageing

The banknote papers used in our work are (Egyptian 5 pounds “EGY”, Egyptian to pounds “EGP”, 1 Riyal “SAR”, 5 Dirham “AED”, 1 Dollar “U$”, 5 Euro “€”) as we mentioned before.

Banknote papers include a lot of security features [189-198]. These security features include intaglio printing, watermark, security thread, see through, microprinting, optical variable ink (OVI), … etc. security features of Banknote papers are very important as it protect Banknote papers due to its essential role in currency counterfeiting resistance. Hence, our duty in this work is how to improve the mechanical properties of banknote papers by CMC modification, CMC layer-by-layer

(LbL) composite and even after accelerated ageing, thermal and UV-radiation ageing without having any influence even small on the effectiveness of Banknote papers' security features.

From Figure 118 to Figure 236 indicates the inspection and significance of different security features of (Egyptian 5 pounds "EGP", Egyptian 10 pounds "EGP", 1 Riyal "SAR", 5 Dirham "AED", 1 Dollar "U$", 5 Euro "€" before treatment, after CMC coating(coated by the highest layer ; 3rd of 0.1% and 1% CMC concentration) and before and after accelerated ageing; thermal and UV-radiation ageing though transmitted light.

From Figure 237 to 332. indicates the inspection and significance of security features of the previous mentioned Banknote papers after CMC coating (coated by the highest layer ;3rd layer of 1% CMC concentration) and before and after accelerated ageing; thermal and UV-radiation ageing through UV-light.

Figure 333 to 428. indicates the inspection and significance of security features of the previous mentioned Banknote papers after CMC coating (coated by the highest layer ; 3rd layer of 1% CMC concentration) and before and after accelerated ageing; thermal and UV-radiation ageing through IR-light.

From all the previous mentioned figures above, we observe that inspite of improving mechanical properties; breaking length and tear factor (resistance) of banknote papers and change the skeletal structure of the fiber network of banknote papers by CMC modification and CMC layer-by-layer (LbL) composite to make paper microfibrils more stronger than the original Banknote papers without any treatment there is no any small effect on the security features of different banknote papers used and mentioned above and its effectiveness is completely perfect even after CMC modification, CMC LbL composite and accelerated ageing; thermal ageing at 140° c for 2 hours and UV-radiation ageing by two different wavelength ($\lambda 1$ = 256, λ_2 = 336nm) at 25° C.This means that mechanical properties improvement by CMC coating and CMC LbL composite formation has no effect on the effectiveness of all security features within banknote papers.

4.Conclusion

We preformed VSC- Instrument(Video Spectral Comparator) to clarify the CMC addition effect on the security features of banknote papers even after accelerated ageing through transmitted light, IR and UV-light. we observe that CMC

modification has no effect even small on paper Banknote security features which indicate that the effectiveness of security features within Banknote papers is marvelous after CMC addition. That indicates that CMC coating is a major industrial operation used to improve appearance, strength properties and printability of paper.

It can be concluded that paper CMC modification has wonderful reflection on the industrial side in the paper industry field.

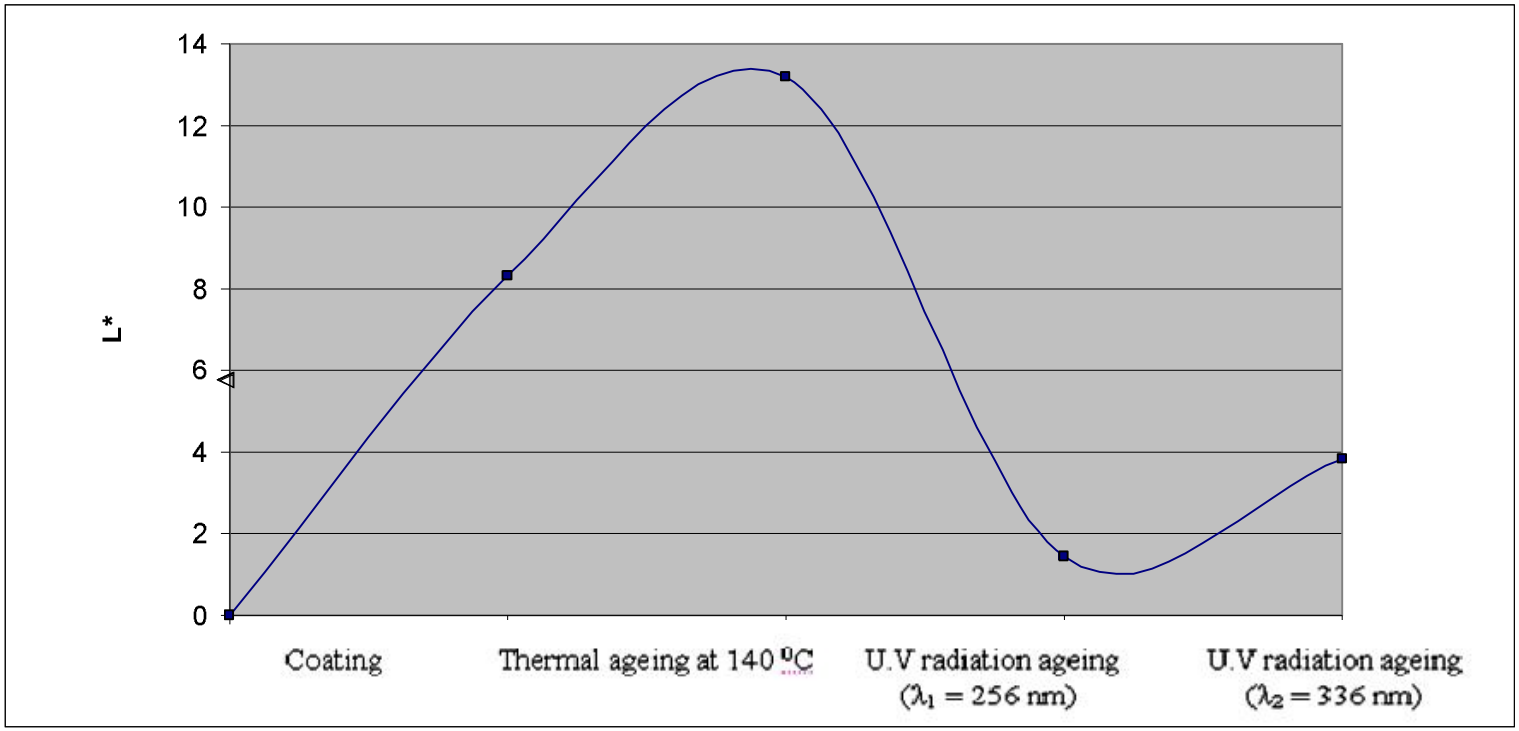

Figure 13: ΔL value against concentration of banknote paper (5 Euro "€") coated by 3rd L of (1%) Carboxymethyl cellulose (CMC) before and after ageing either by thermal ageing at 140 ^{0}C or by UV radiation (λ_1= 256 nm, λ_2 = 336 nm).*

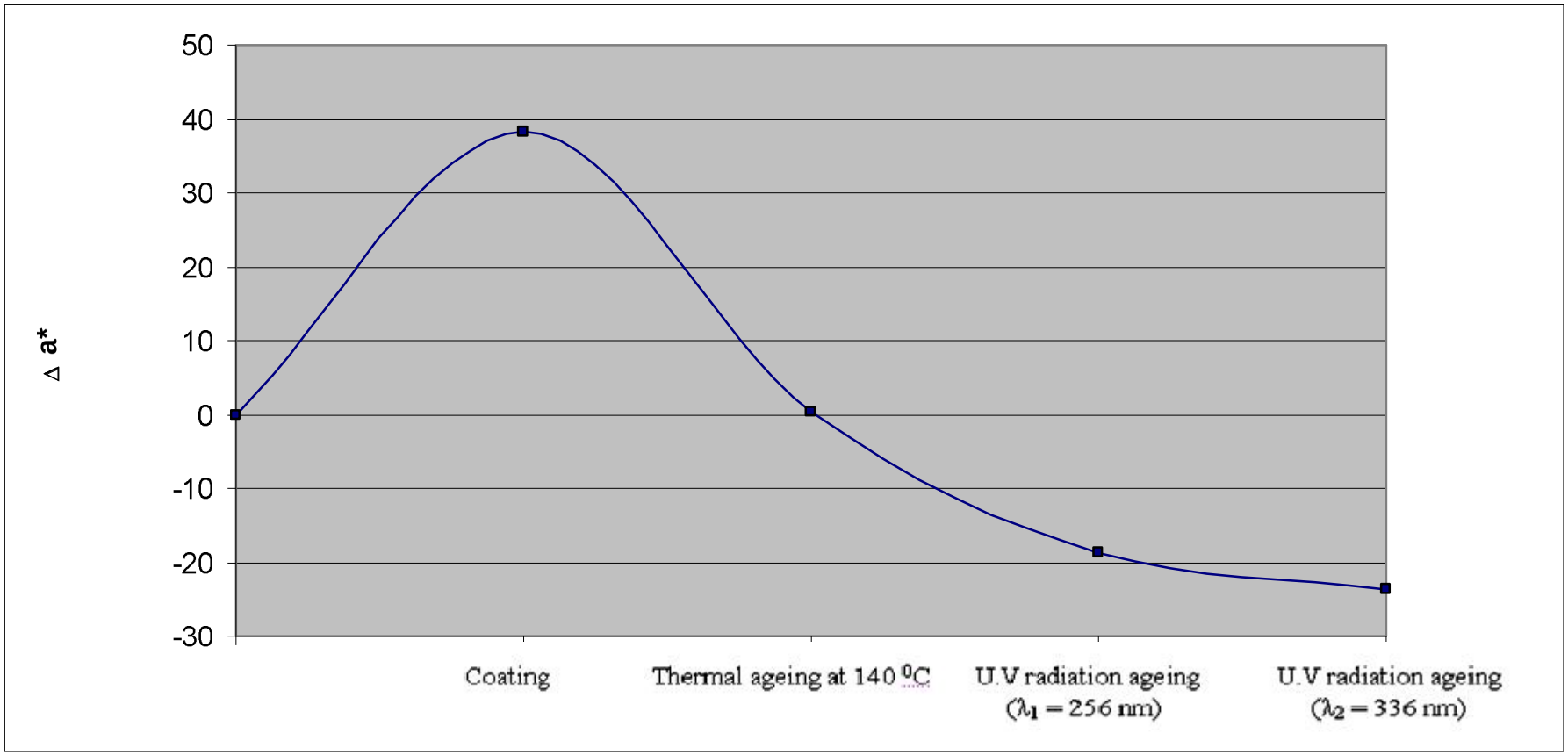

Figure 14:Δa value against concentration of banknote paper (5 Euro "€") coated by 3rd L of (1%) Carboxymethyl cellulose (CMC) before and after ageing either by thermal ageing at 140 ^{0}C or by UV radiation (λ_1= 256 nm, λ_2 = 336 nm).*

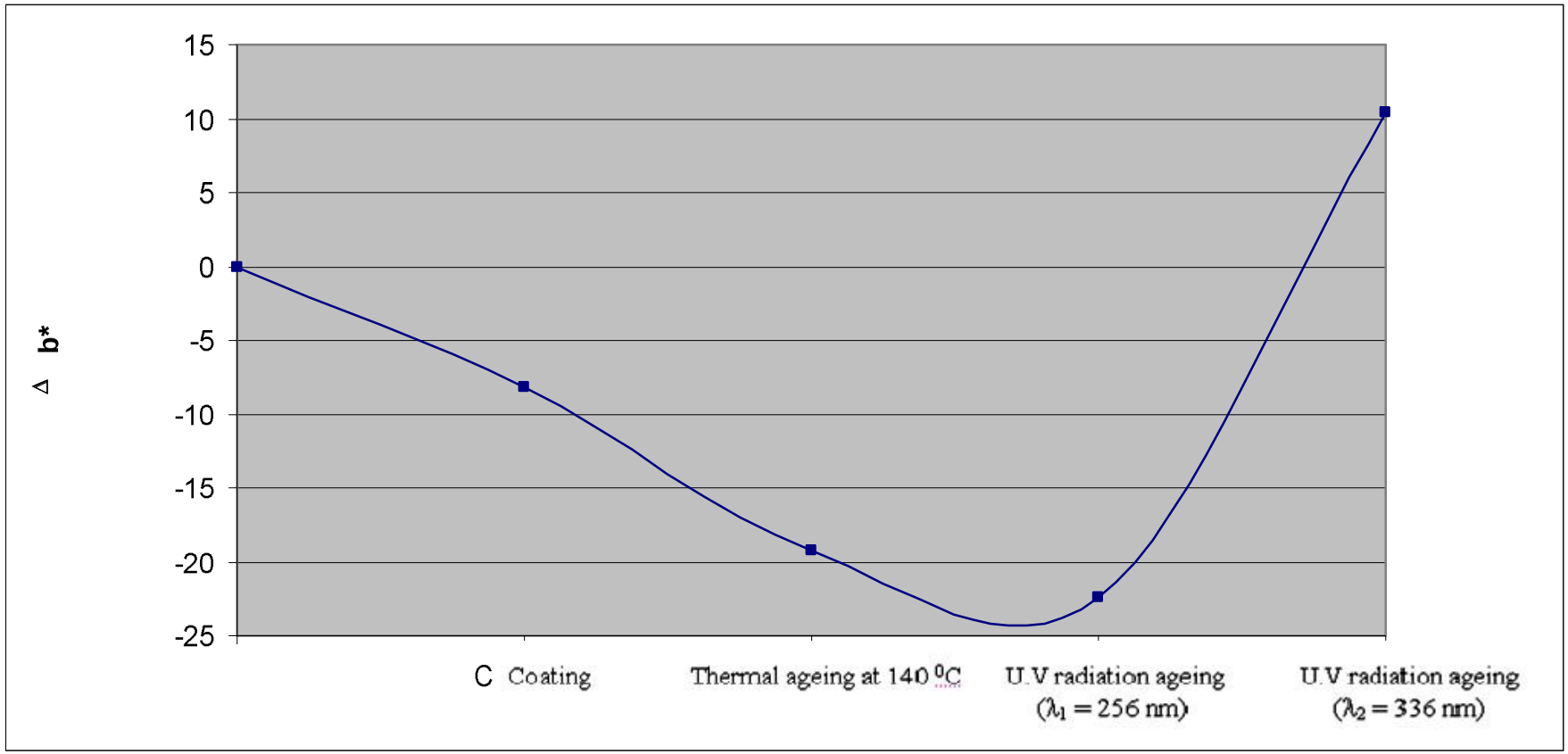

Figure 15: Δb value against concentration of banknote paper (5 Euro "€") coated by 3rd L of (1%) Carboxymethyl cellulose (CMC) before and after ageing either by thermal ageing at 140 ^{0}C or by UV radiation (λ_1= 256 nm, λ_2 = 336 nm)*

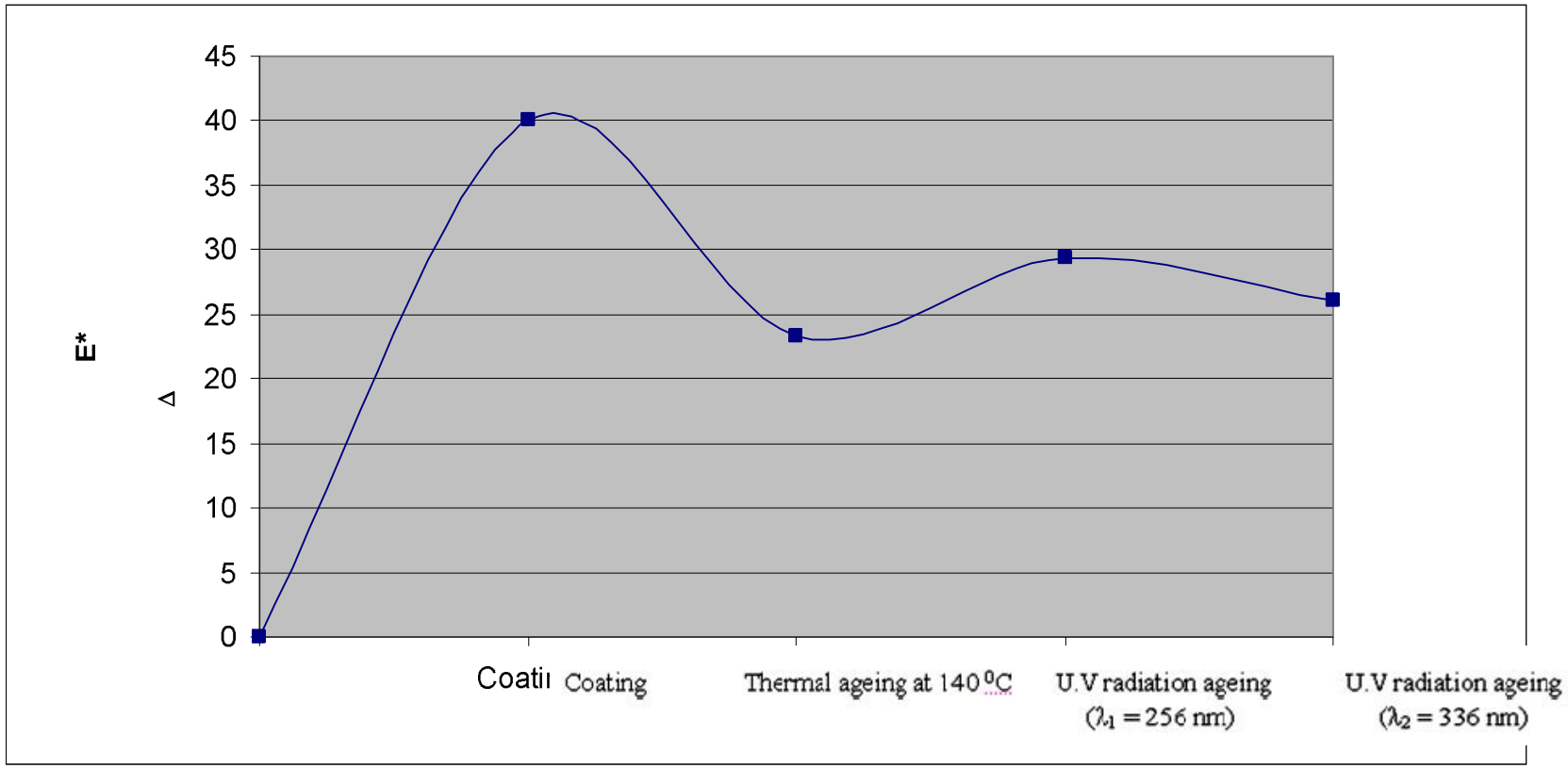

Figure16 : ΔE value against concentration of banknote paper (5 Euro "€") coated by 3rd L of (1%) Carboxymethyl cellulose (CMC) before and after ageing either by thermal ageing at 140 ^{0}C or by UV radiation (λ_1= 256 nm, λ_2 = 336 nm).*

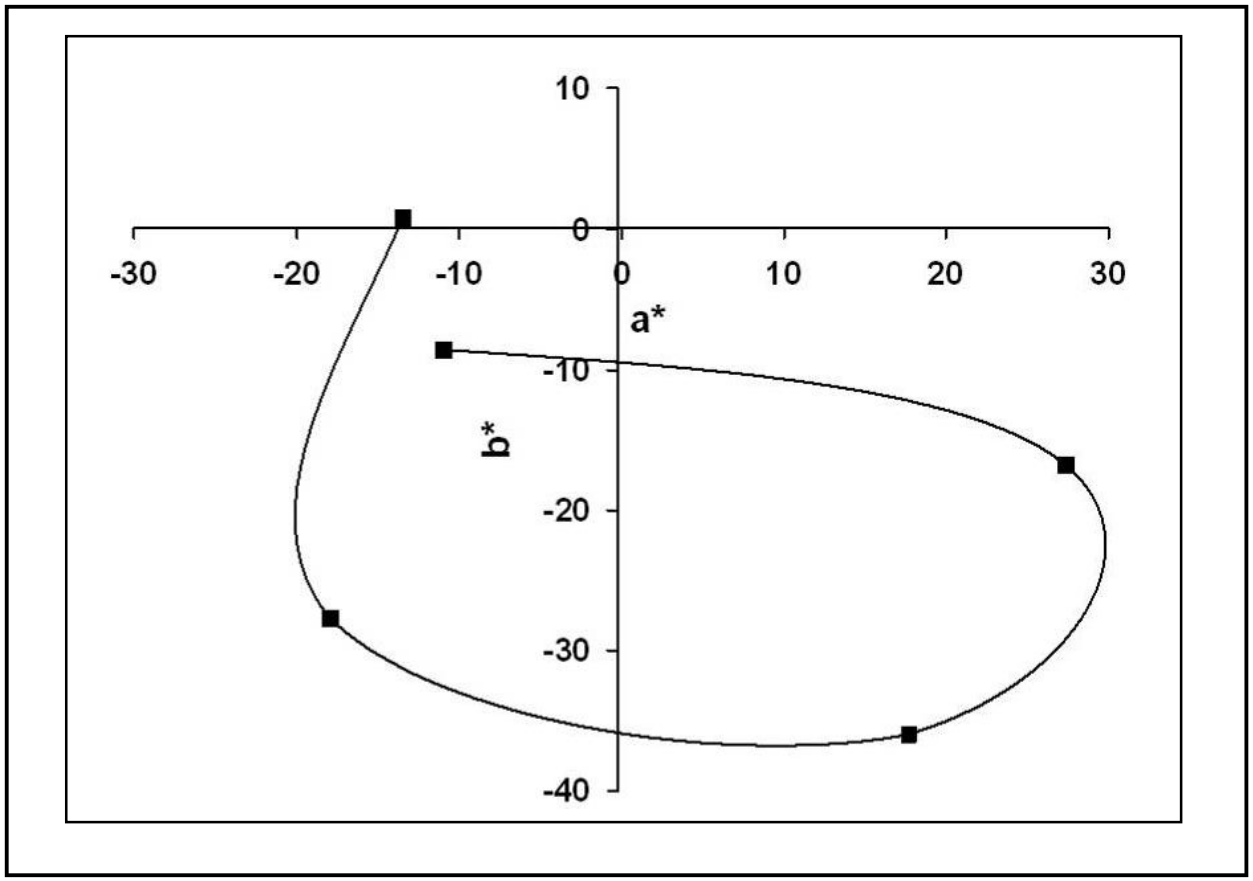

Figure 17: Effect of coating banknote paper (5 Euro "€") by 3rd L of (1%) Carboxymethyl cellulose (CMC) before and after ageing either by thermal ageing at 140 ^{0}C or by UV radiation (λ_1= 256 nm, λ_2 = 336 nm) on color change.

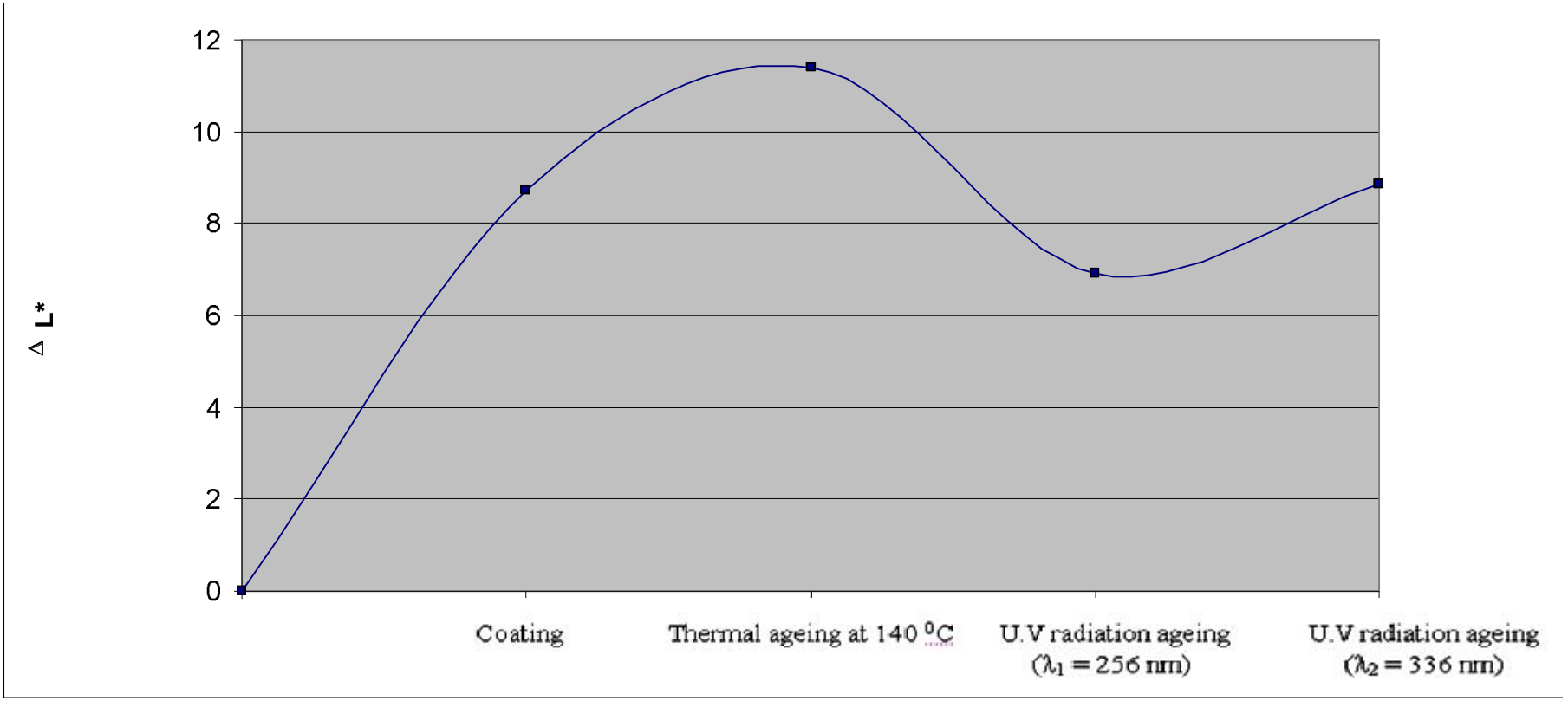

Figure 18: ΔL value against concentration of banknote paper (5 Dirham "AED") coated by 3rd L of (1%) Carboxymethyl cellulose (CMC) before and after ageing either by thermal ageing at 140 ^{0}C or by UV radiation (λ_1= 256 nm, λ_2 = 336 nm).*

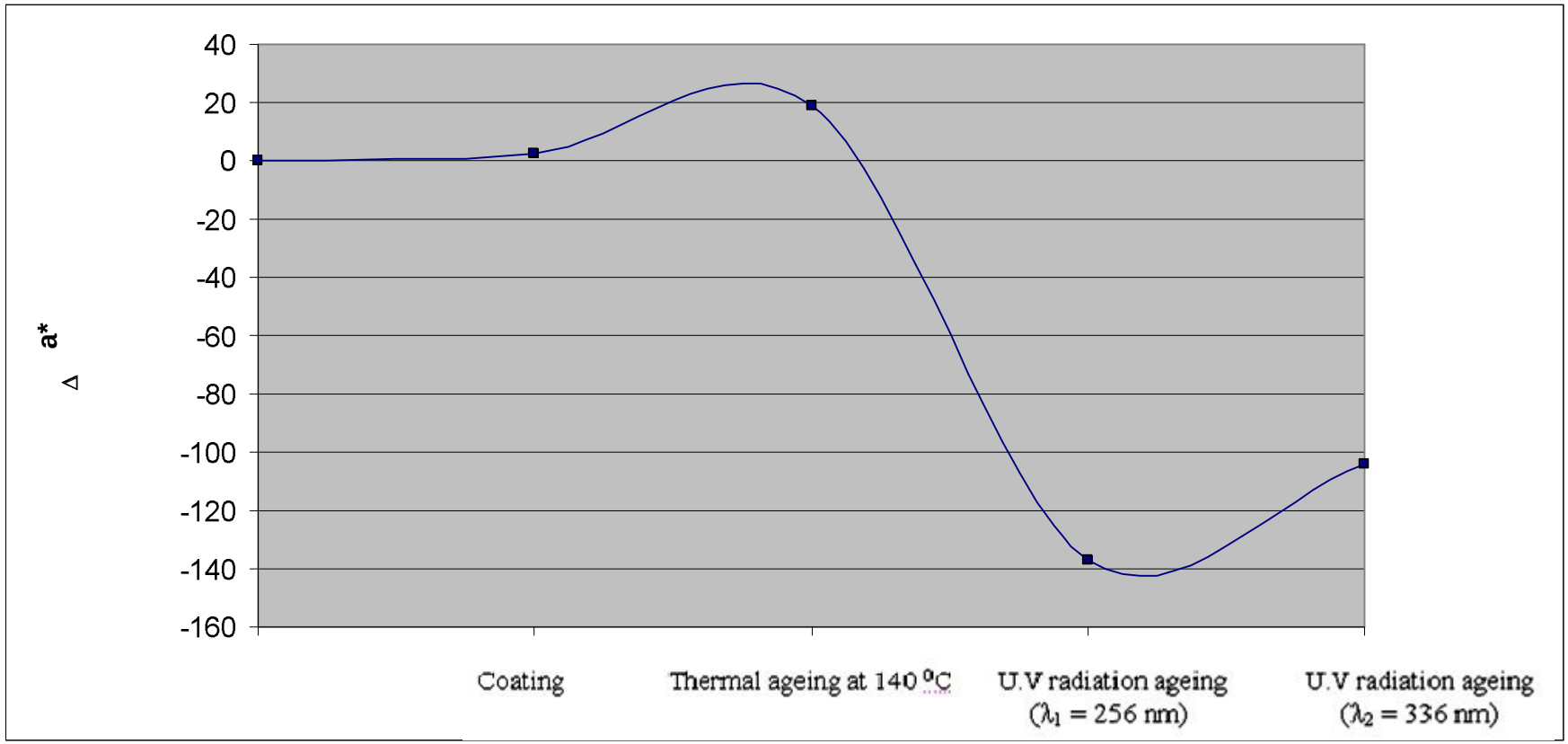

Figure 19: Δa value against concentration of banknote paper (5 Dirham "AED") coated by 3rd L of (1%) Carboxymethyl cellulose (CMC) before and after ageing either by thermal ageing at 140 ^{0}C or by UV radiation (λ_1= 256 nm, λ_2 = 336 nm).*

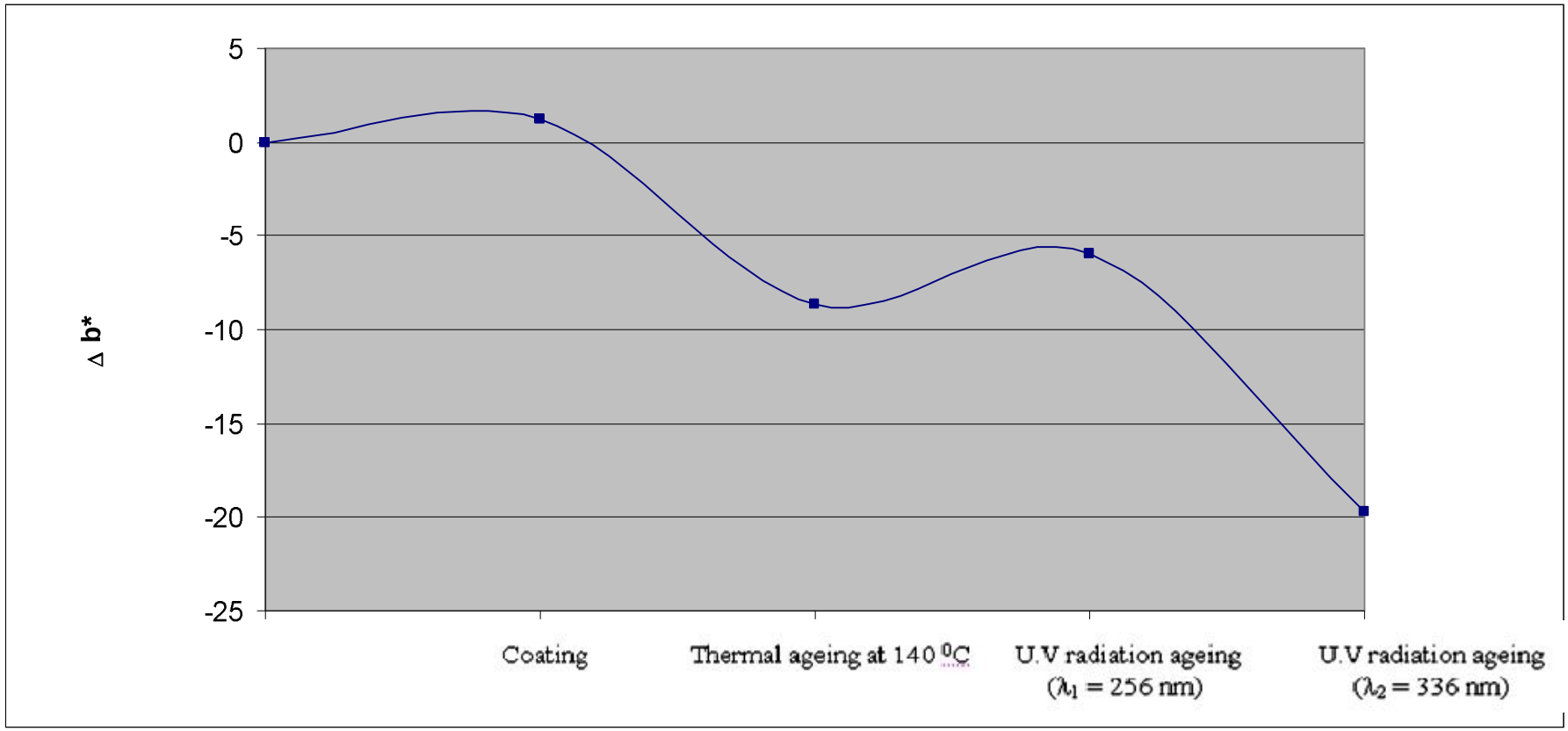

Figure 20: Δb value against concentration of banknote paper (5 Dirham "AED") coated by 3rd L of (1%) Carboxymethyl cellulose (CMC) before and after ageing either by thermal ageing at 140 ^{0}C or by UV radiation (λ_1= 256 nm, λ_2 = 336 nm).*

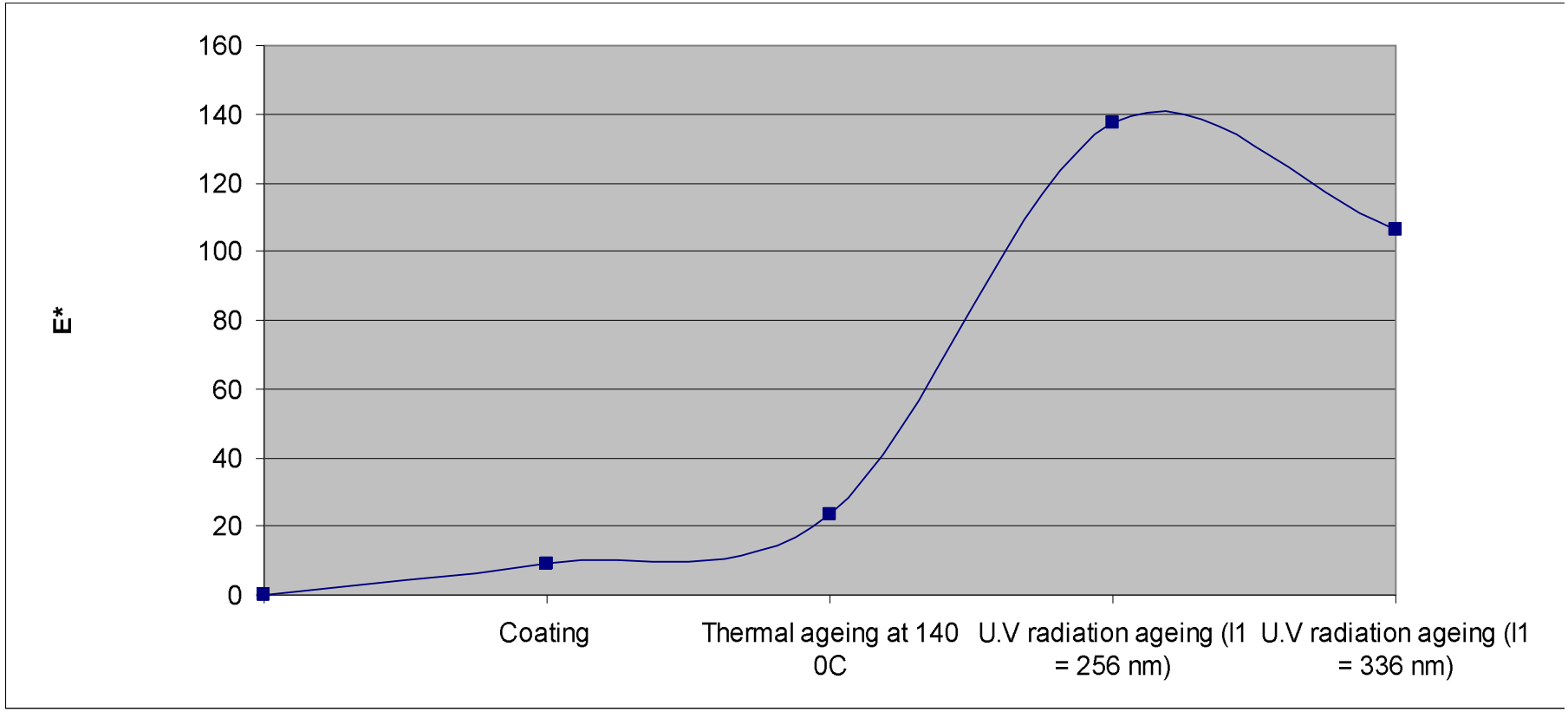

Figure 21: ΔE value against concentration of banknote paper (5 Dirham "AED") coated by 3rd L of (1%) Carboxymethyl cellulose (CMC) before and after ageing either by thermal ageing at 140 ^{0}C or by UV radiation (λ_1= 256 nm, λ_2 = 336 nm).*

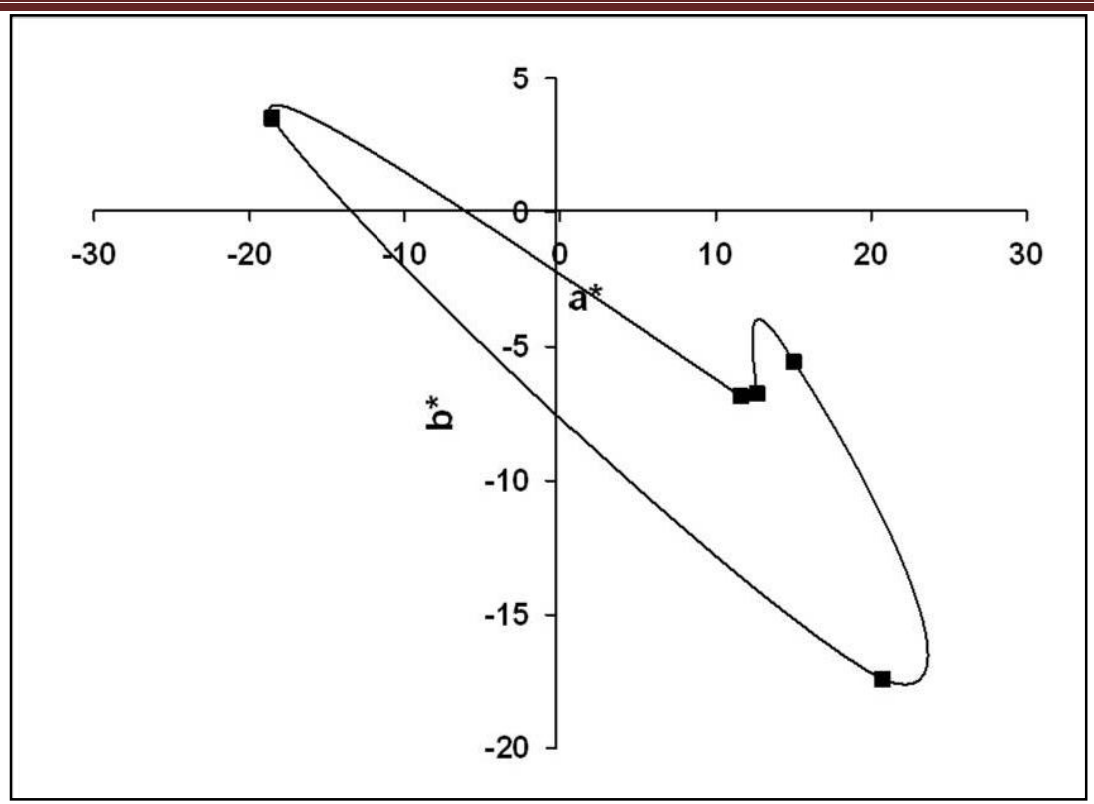

Figure 22: Effect of coating banknote paper (5 Dirham "AED") by 3rd L of (1%) Carboxymethyl cellulose (CMC) before and after ageing either by thermal ageing at 140 ^{0}C or by UV radiation (λ_1= 256 nm, λ_2 = 336 nm) on color change.

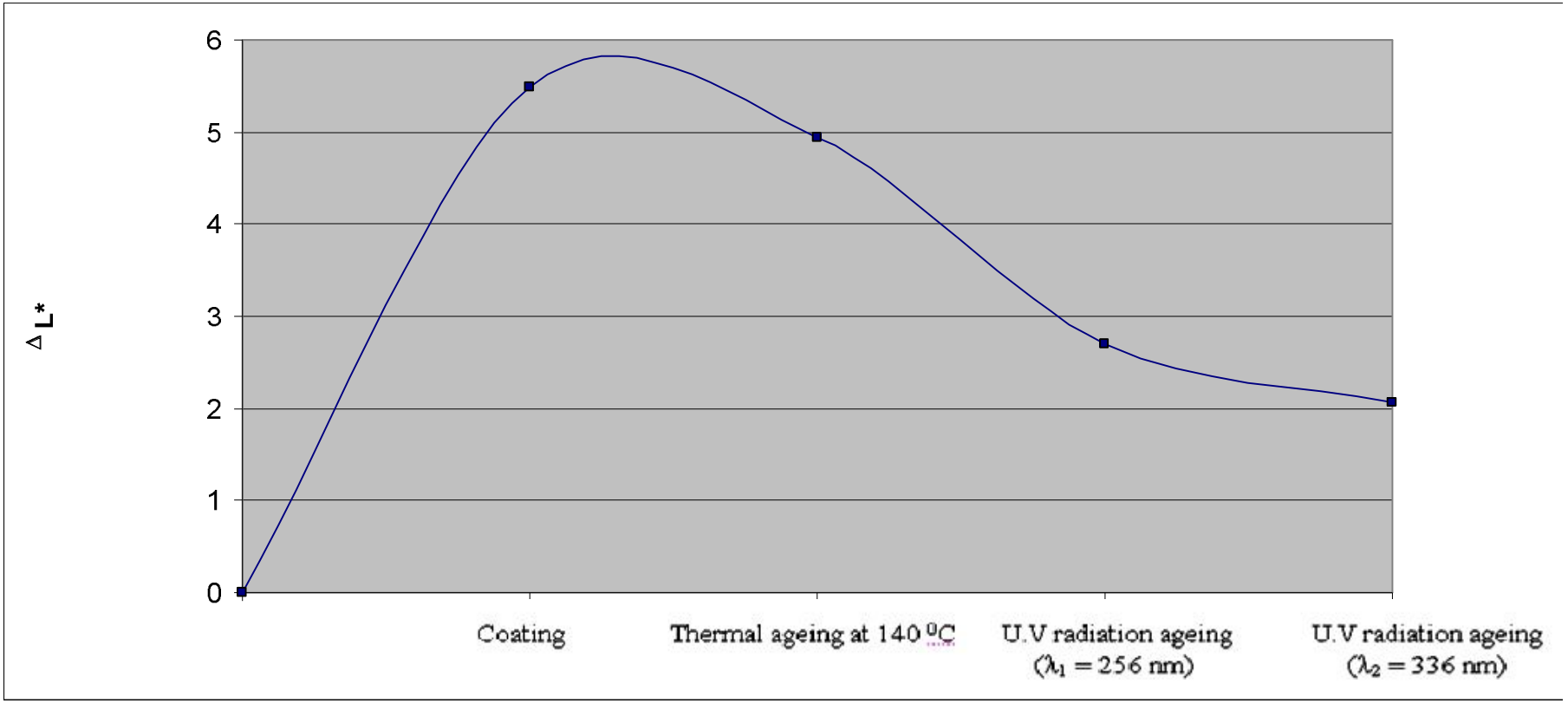

Figure 23: ΔL value of banknote paper (5 Riyals "SAR") coated by 3rd L of (1%) Carboxymethyl cellulose (CMC) before and after ageing either by thermal ageing at 140 ^{0}C or by UV radiation (λ_1= 256 nm, λ_2 = 336 nm).*

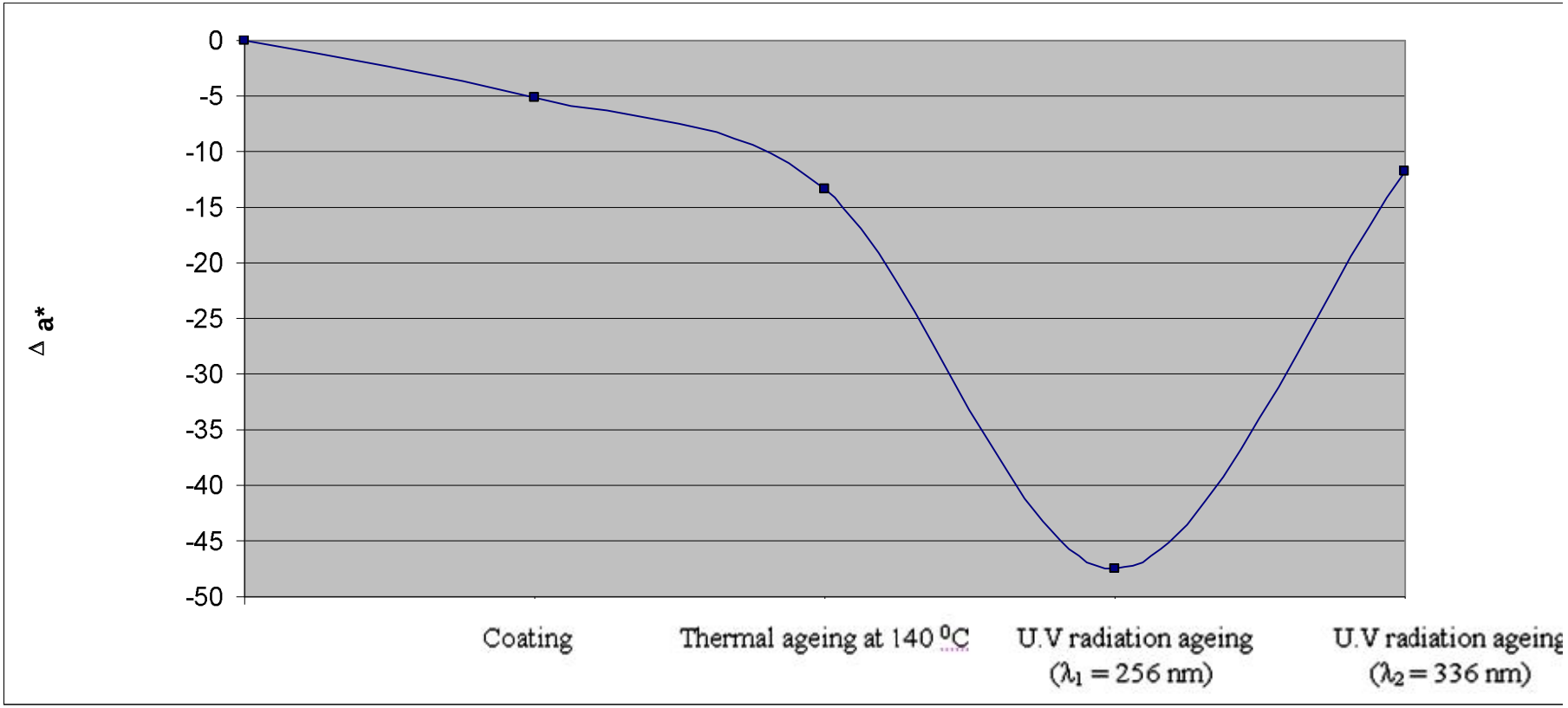

Figure 24: Δa value of banknote paper (5 Riyals "SAR") coated by 3rd L of (1%) Carboxymethyl cellulose (CMC) before and after ageing either by thermal ageing at 140 ^{0}C or by UV radiation (λ_1= 256 nm, λ_2 = 336 nm).*

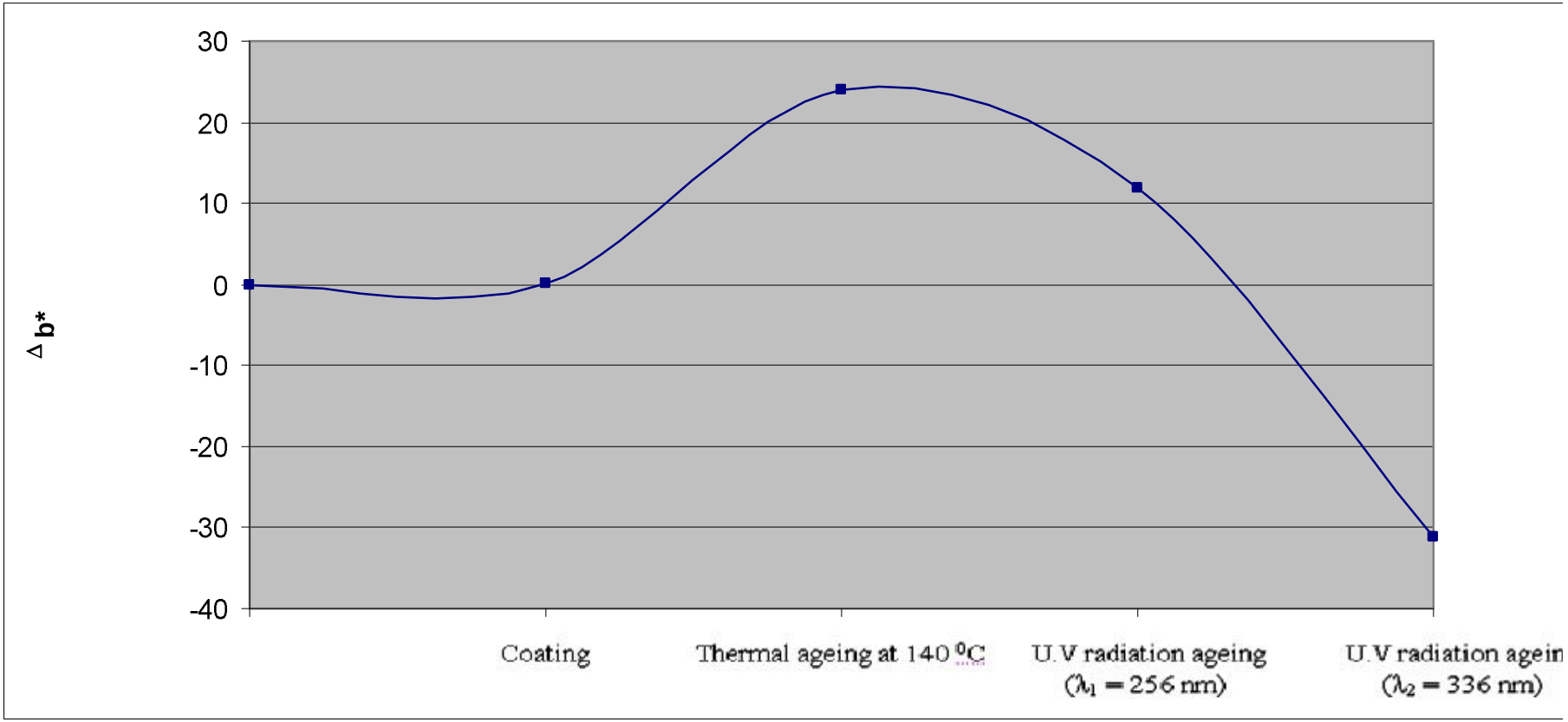

*Figure 25: Δb*value of banknote paper (5 Riyals "SAR") coated by 3rd L of (1%) Carboxymethyl cellulose (CMC) before and after ageing either by thermal ageing at 140 ^{0}C or by UV radiation (λ_1= 256 nm, λ_2 = 336 nm).*

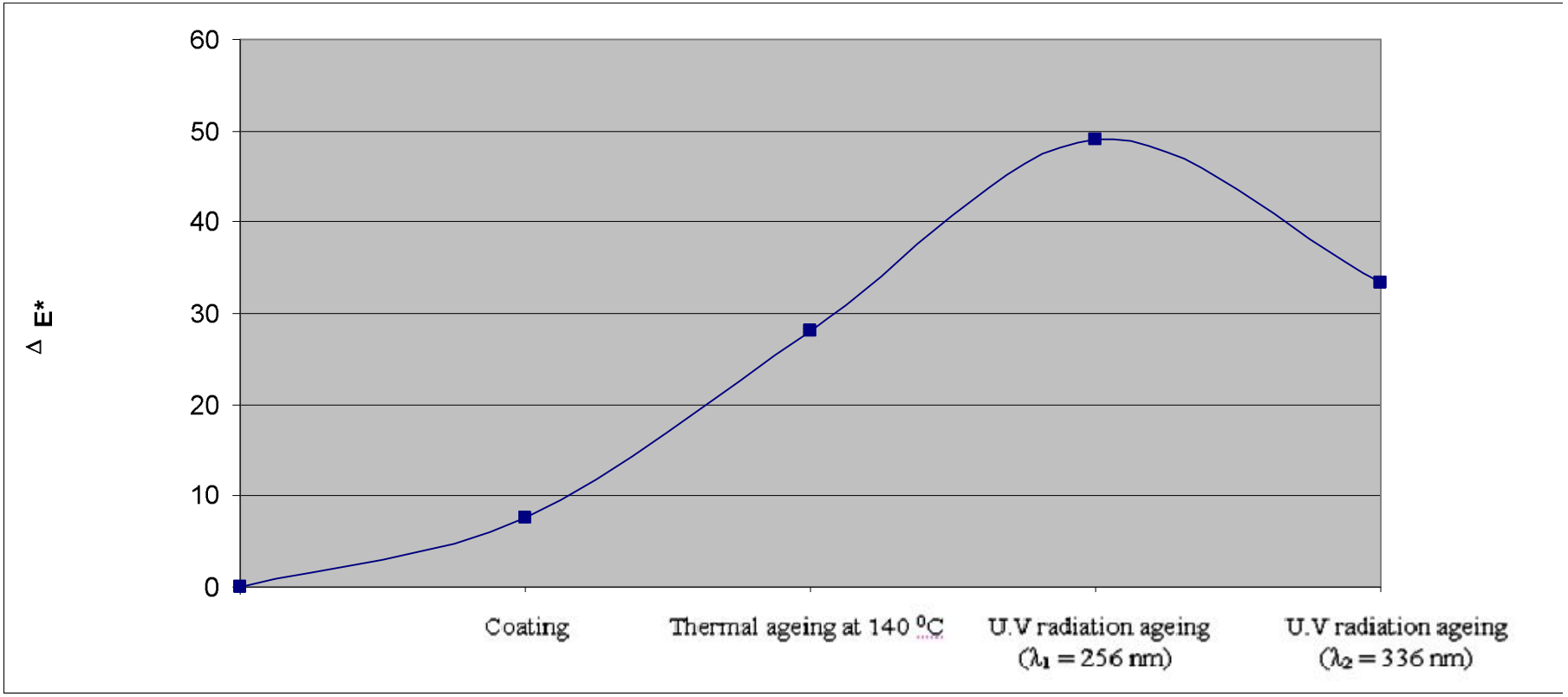

Figure 26: ΔE-value of banknote paper (5 Riyals "SAR") coated by 3rd L of (1%) Carboxymethyl cellulose (CMC) before and after ageing either by thermal ageing at 140 ^{0}C or by UV radiation (λ_1= 256 nm, λ_2 = 336 nm).*

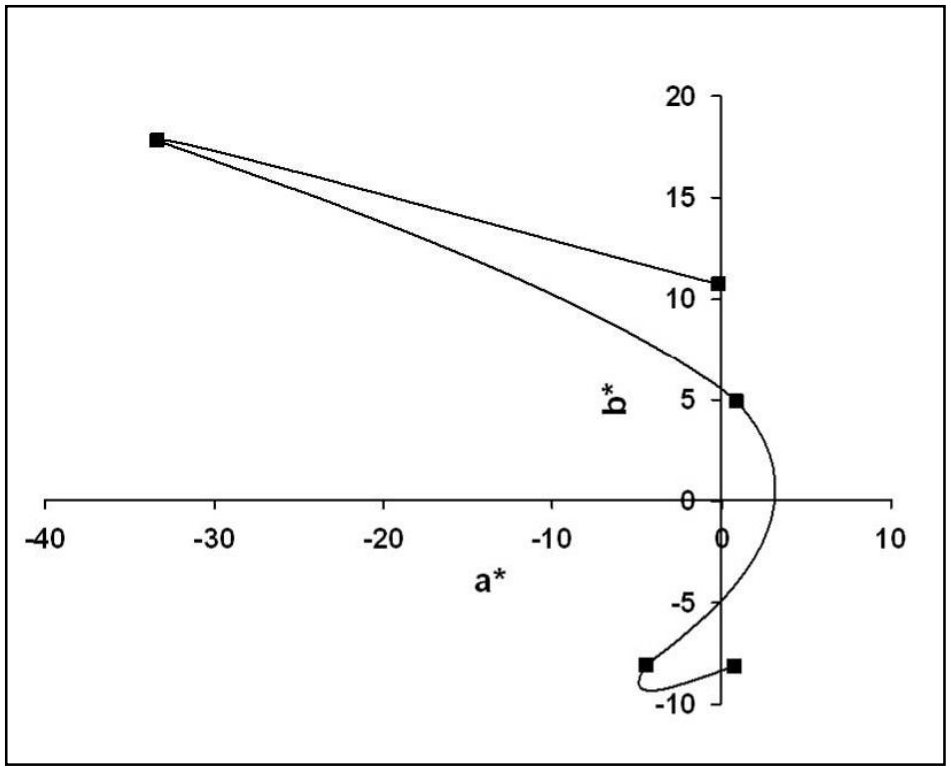

Figure 27: Effect of coating banknote paper (5 Riyals "SAR") by 3rd L of (1%) Carboxymethyl cellulose (CMC) before and after ageing either by thermal ageing at 140 ^{0}C or by UV radiation (λ_1= 256 nm, λ_2 = 336 nm)on color change.

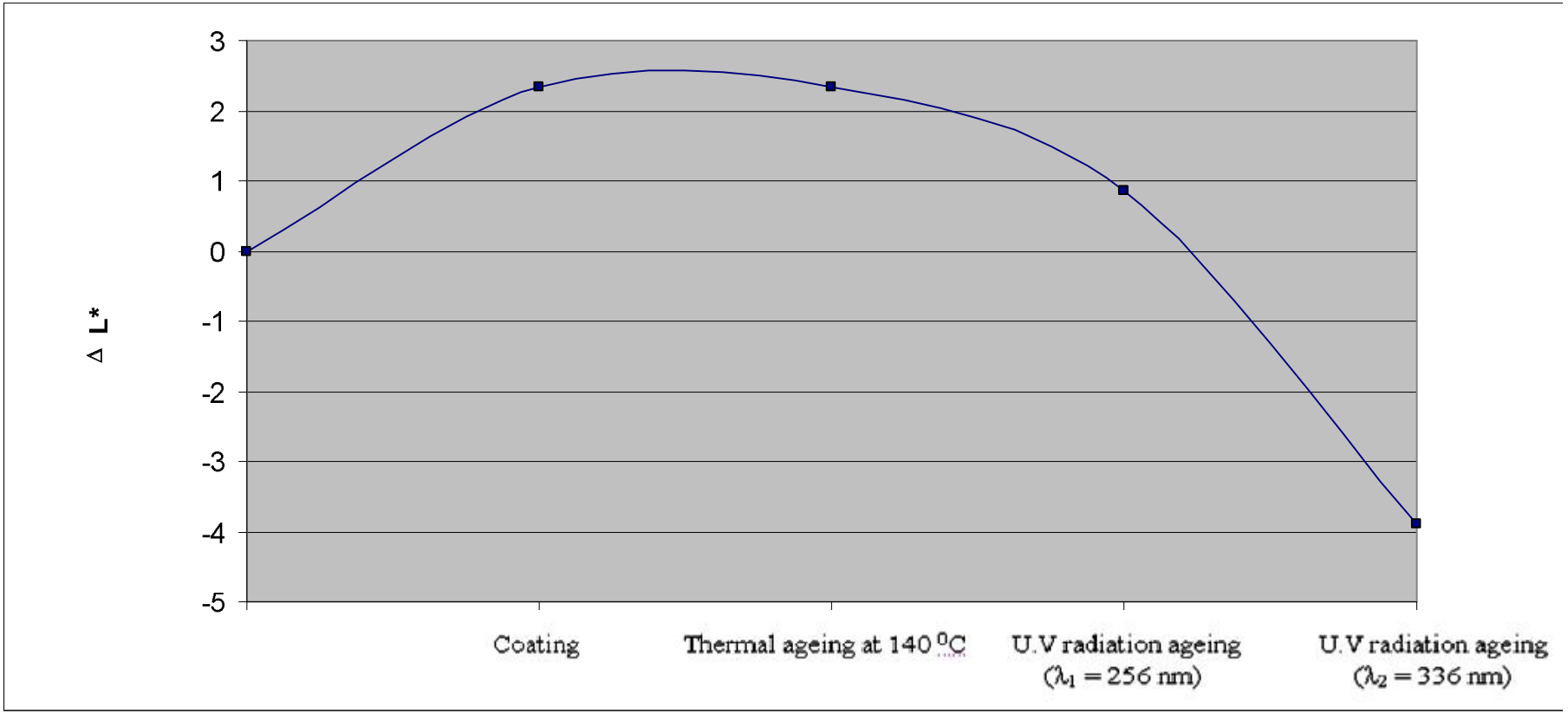

Figure 28: ΔL value of banknote paper (Egyptian 5 pounds "EGP") coated by 1st L of (0.1%) Carboxymethyl cellulose (CMC) before and after ageing either by thermal ageing at 140 ^{0}C or by UV radiation (λ_1= 256 nm, λ_2 = 336 nm).*

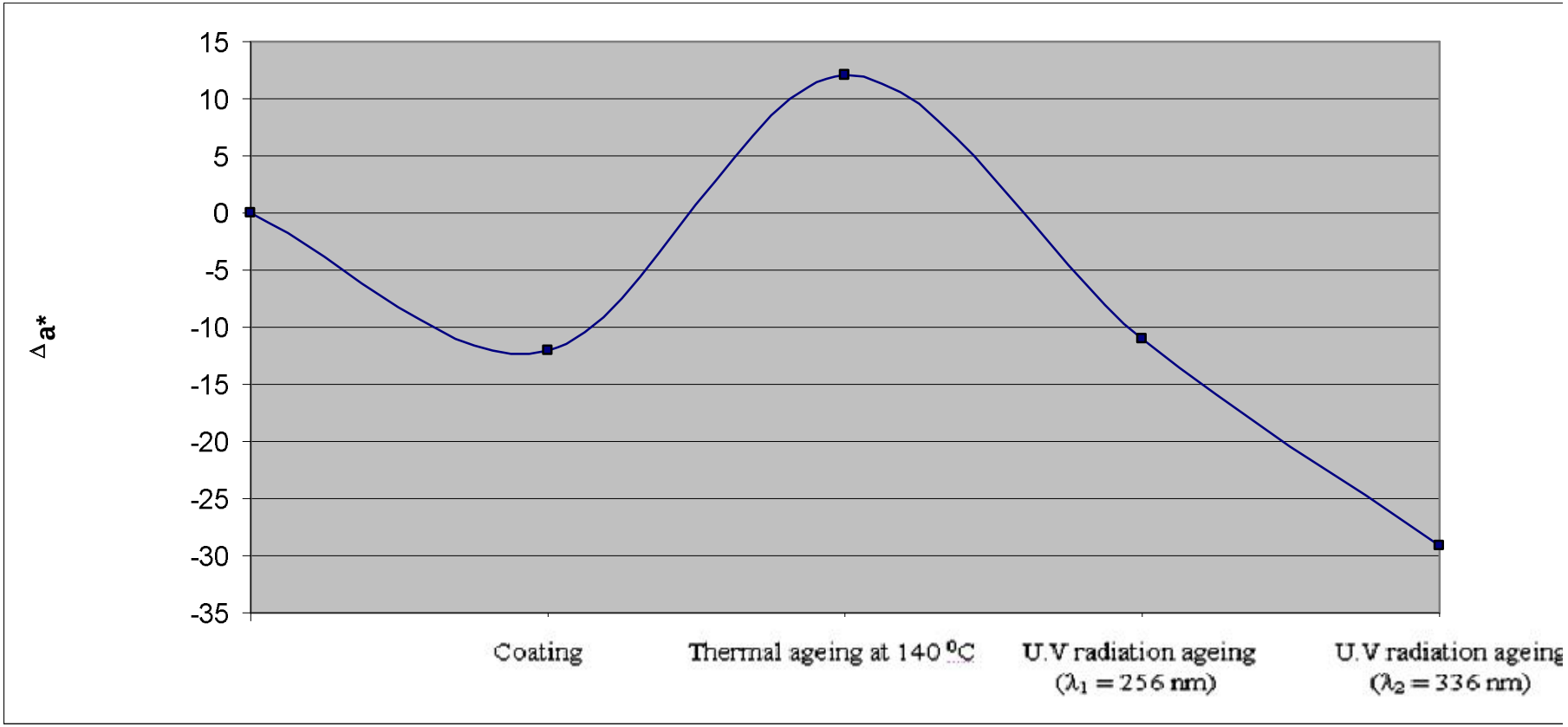

Figure 29 : Δa value of banknote paper (Egyptian 5 pounds "EGP") coated by 1st L of (0.1%) Carboxymethyl cellulose (CMC) before and after ageing either by thermal ageing at 140 ^{0}C or by UV radiation (λ_1= 256 nm, λ_2 = 336 nm).*

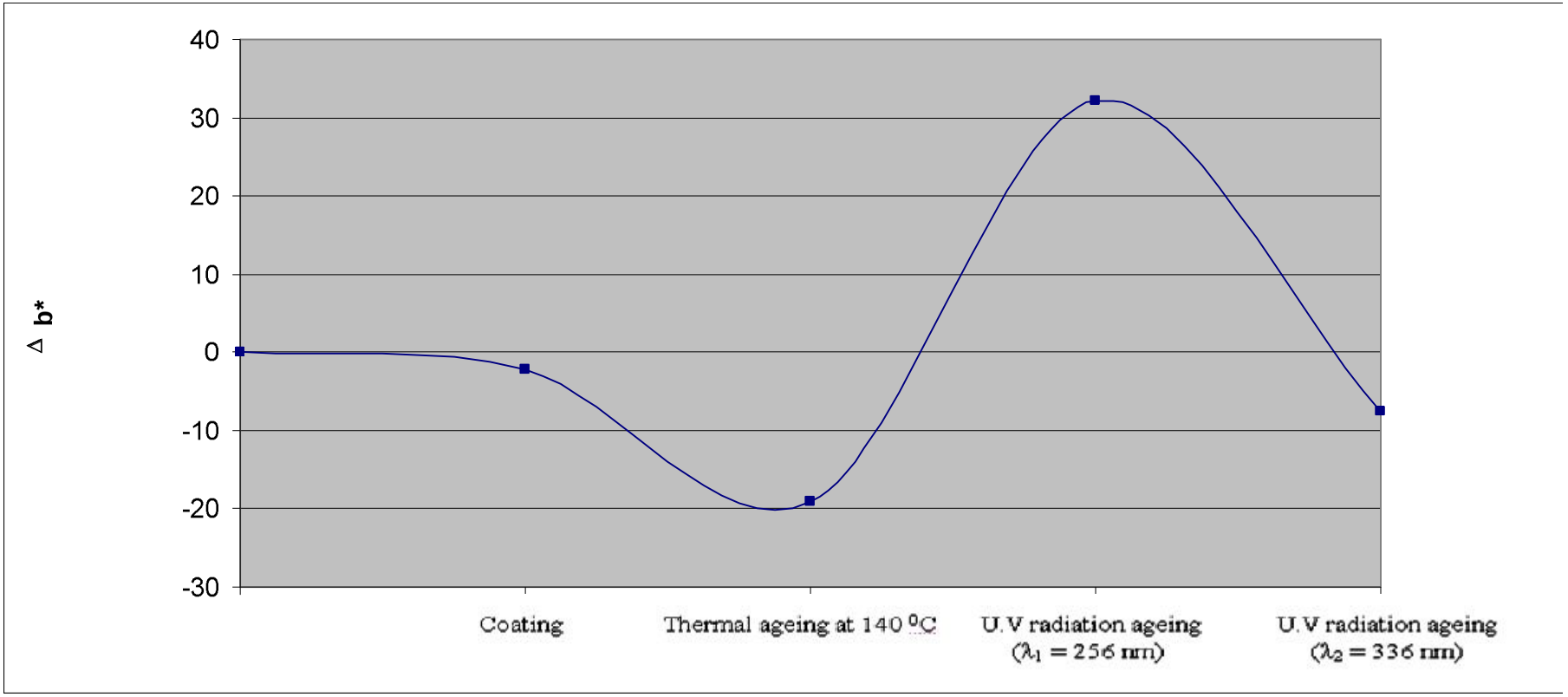

Figure 30: Δb value of banknote paper (Egyptian 5 pounds "EGP") coated by 1st L of (0.1%) Carboxymethyl cellulose (CMC) before and after ageing either by thermal ageing at 140 °C or by UV radiation (λ_1= 256 nm, λ_2 = 336 nm).*

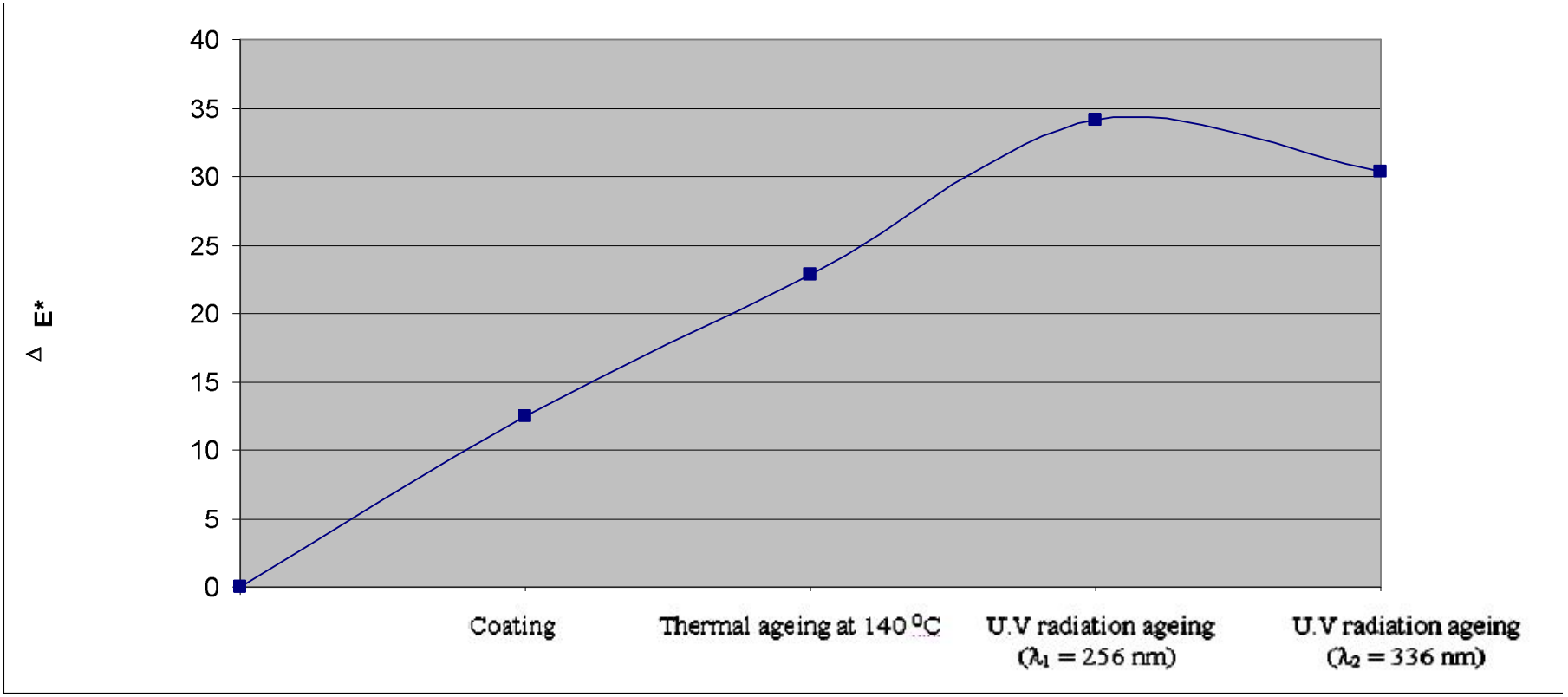

Figure 31: ΔE value of banknote paper (Egyptian 5 pounds "EGP") coated by 1st L of (0.1%) Carboxymethyl cellulose (CMC) before and after ageing either by thermal ageing at 140 ^{0}C or by UV radiation (λ_1= 256 nm, λ_2 = 336 nm).*

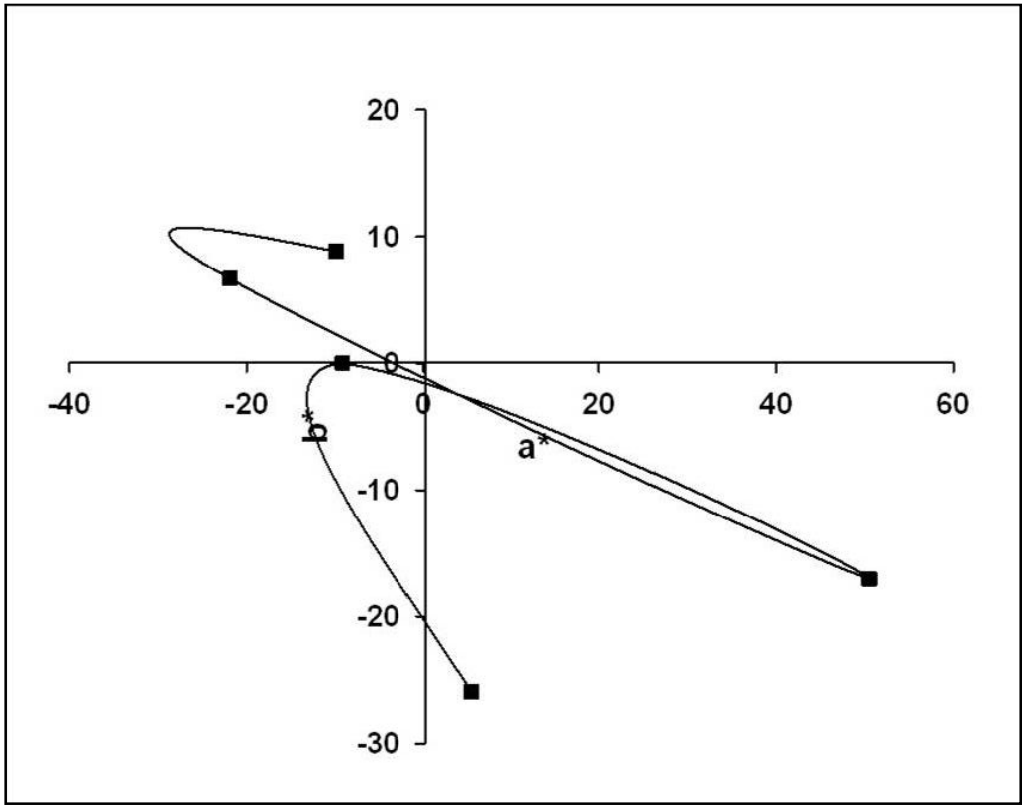

Figure 32: Effect of coating banknote paper (Egyptian 5 pounds "EGP") by 1st L of (0.1%) Carboxymethyl cellulose (CMC) before and after ageing either by thermal ageing at 140 ^{0}C or by UV radiation (λ_1= 256 nm, λ_2 = 336 nm) on color change.

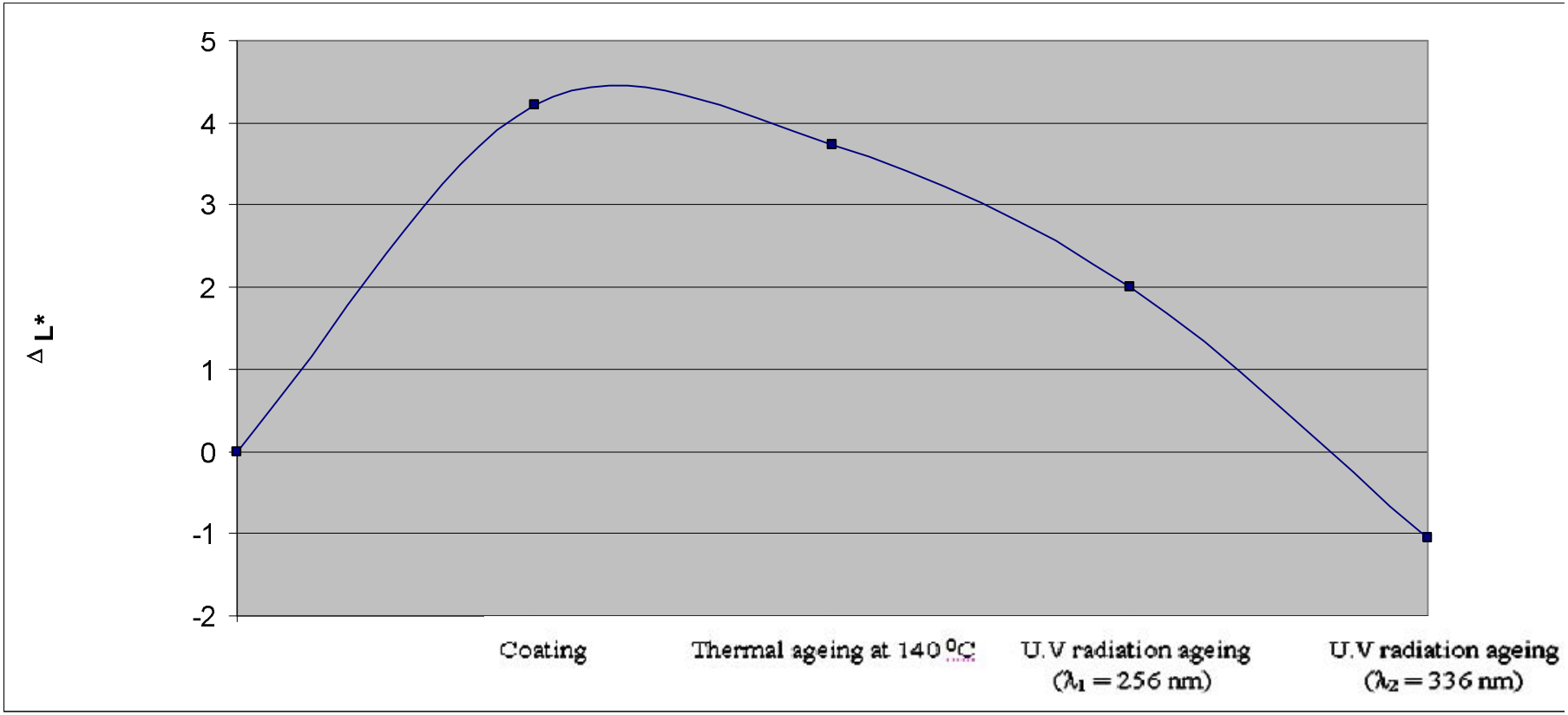

Figure 33: ΔL value of banknote paper (Egyptian 5 pounds "EGP") coated by 1st L of (1%) Carboxymethyl cellulose (CMC) before and after ageing either by thermal ageing at 140 ^{0}C or by UV radiation (λ_1= 256 nm, λ_2 = 336 nm).*

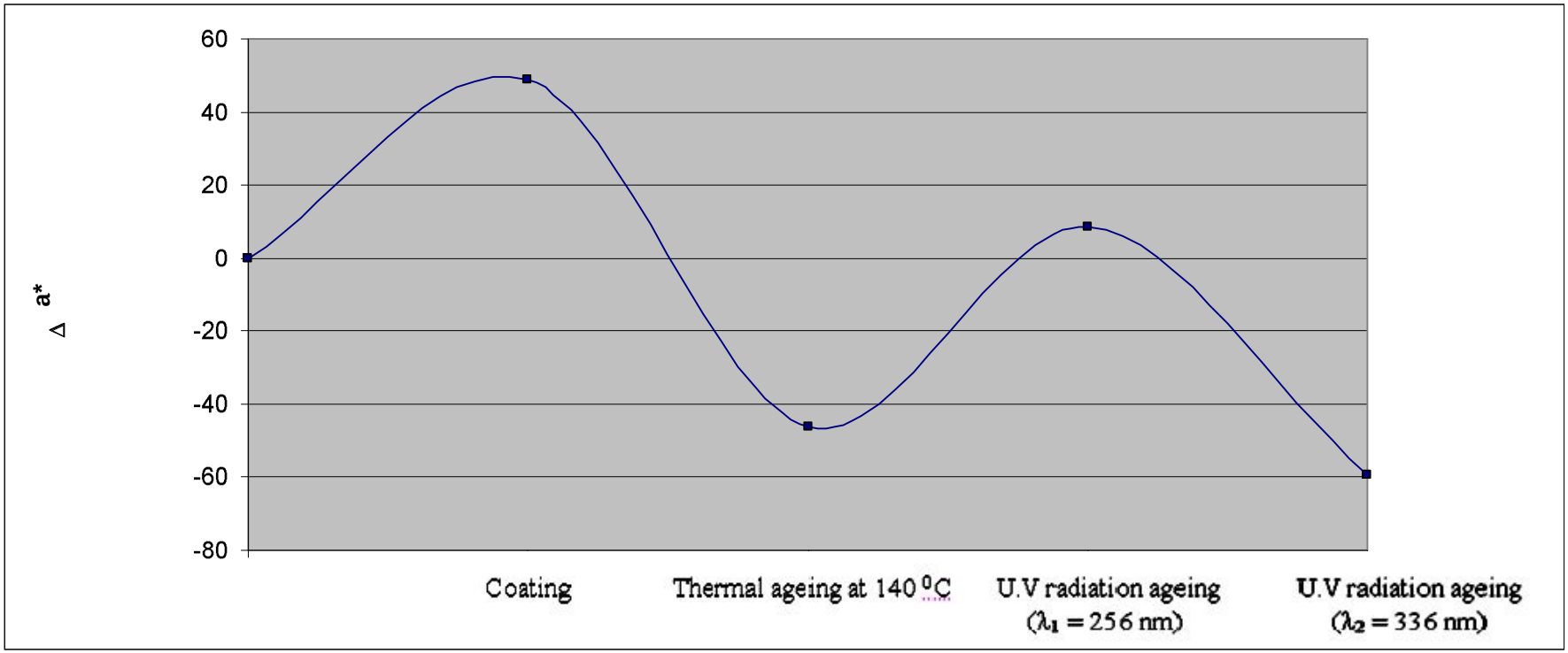

Figure 34: Δa value of banknote paper (Egyptian 5 pounds "EGP") coated by 1st L of (1%) Carboxymethyl cellulose (CMC) before and after ageing either by thermal ageing at 140 ^{0}C or by UV radiation (λ_1= 256 nm, λ_2 = 336 nm).*

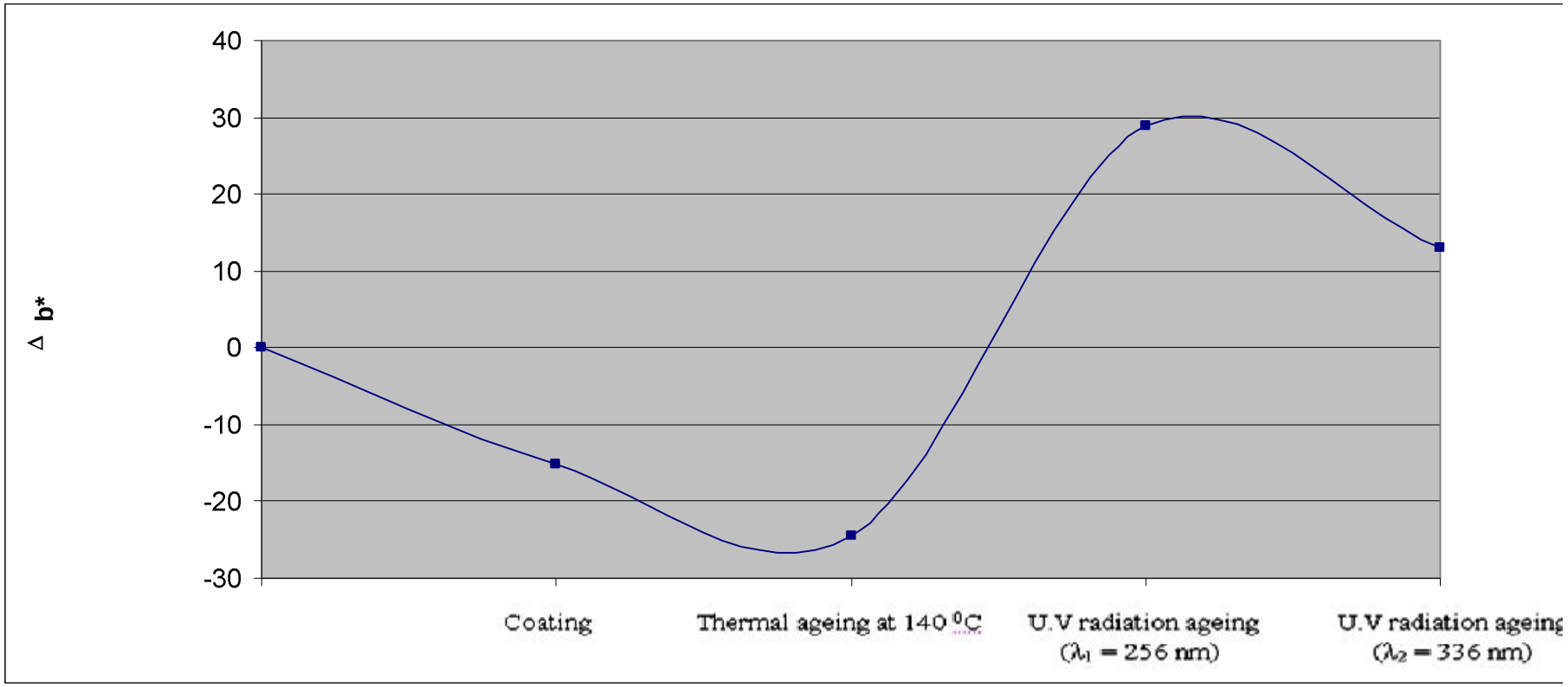

Figure 35: Δb value of banknote paper (Egyptian 5 pounds "EGP") coated by 1st L of (1%) Carboxymethyl cellulose (CMC) before and after ageing either by thermal ageing at 140 ^{0}C or by UV radiation (λ_1= 256 nm, λ_2 = 336 nm).*

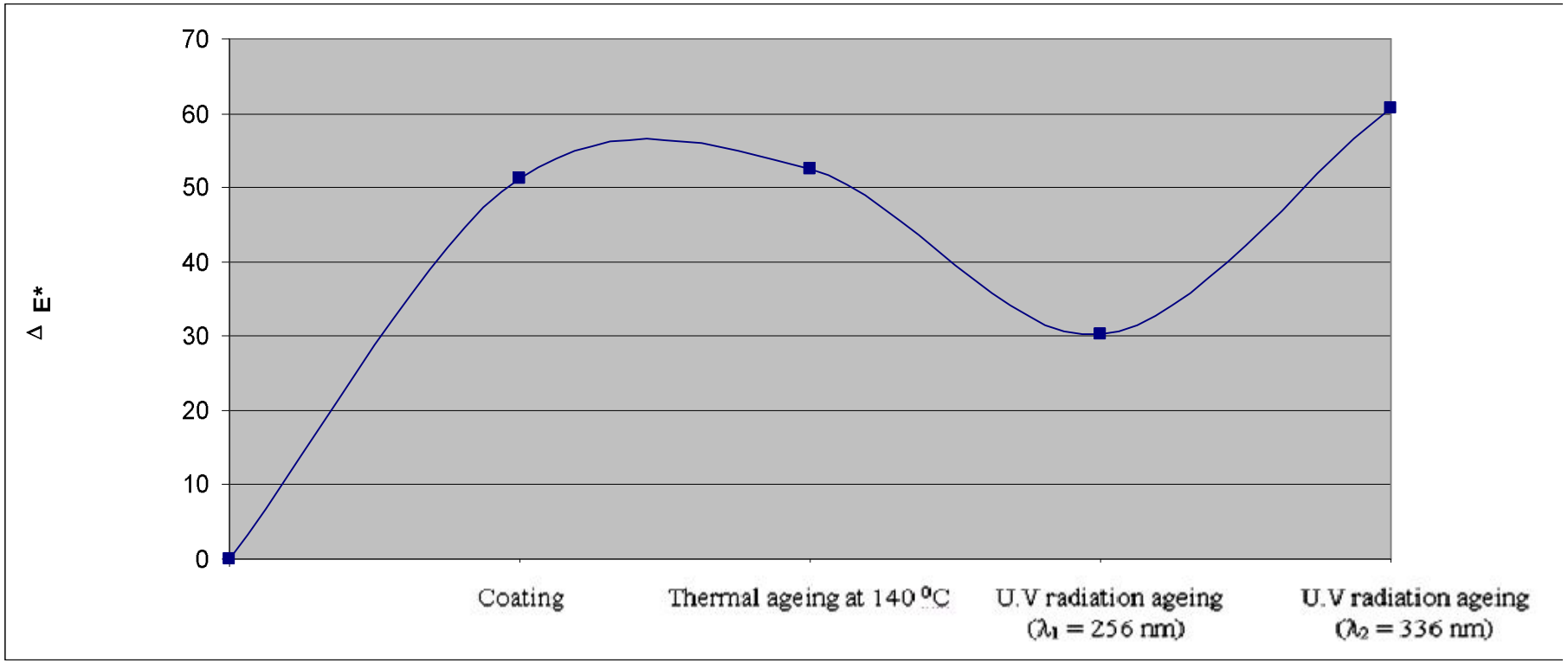

Figure 36: ΔE value of banknote paper (Egyptian 5 pounds "EGP") coated by 1st L of (1%) Carboxymethyl cellulose (CMC) before and after ageing either by thermal ageing at 140 ^{0}C or by UV radiation (λ_1= 256 nm, λ_2 = 336 nm).*

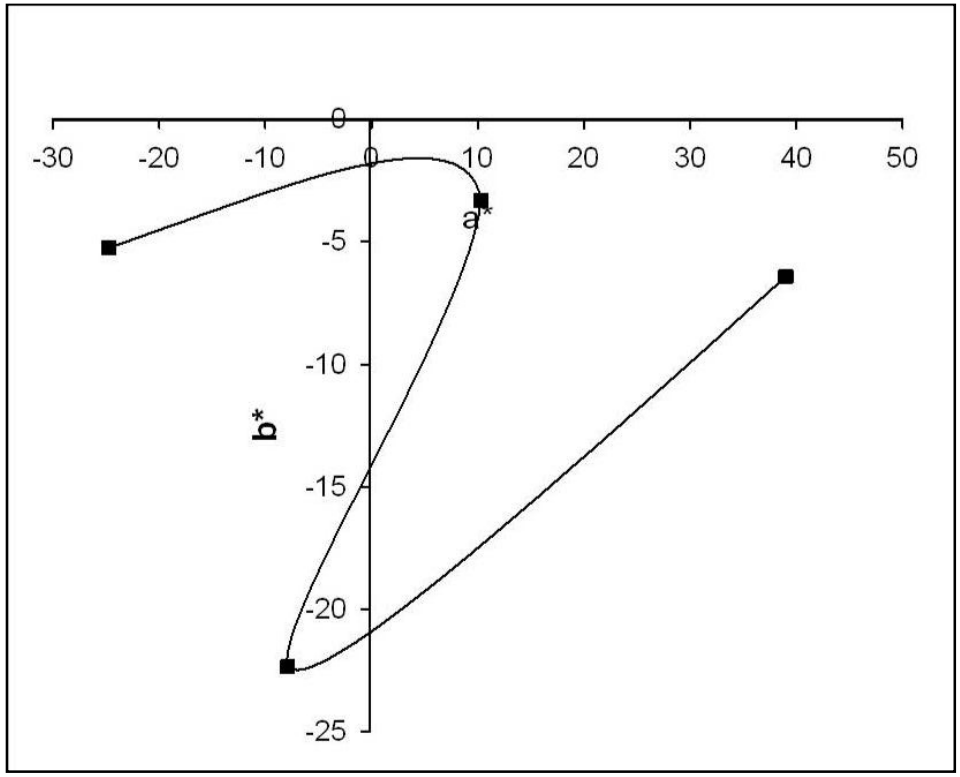

Figure 37: Effect of coating banknote paper (Egyptian 5 pounds "EGP") by 1st L of (1%) Carboxymethyl cellulose (CMC) before and after ageing either by thermal ageing at 140 ^{0}C or by UV radiation (λ_1= 256 nm, λ_2 = 336 nm) on color change.

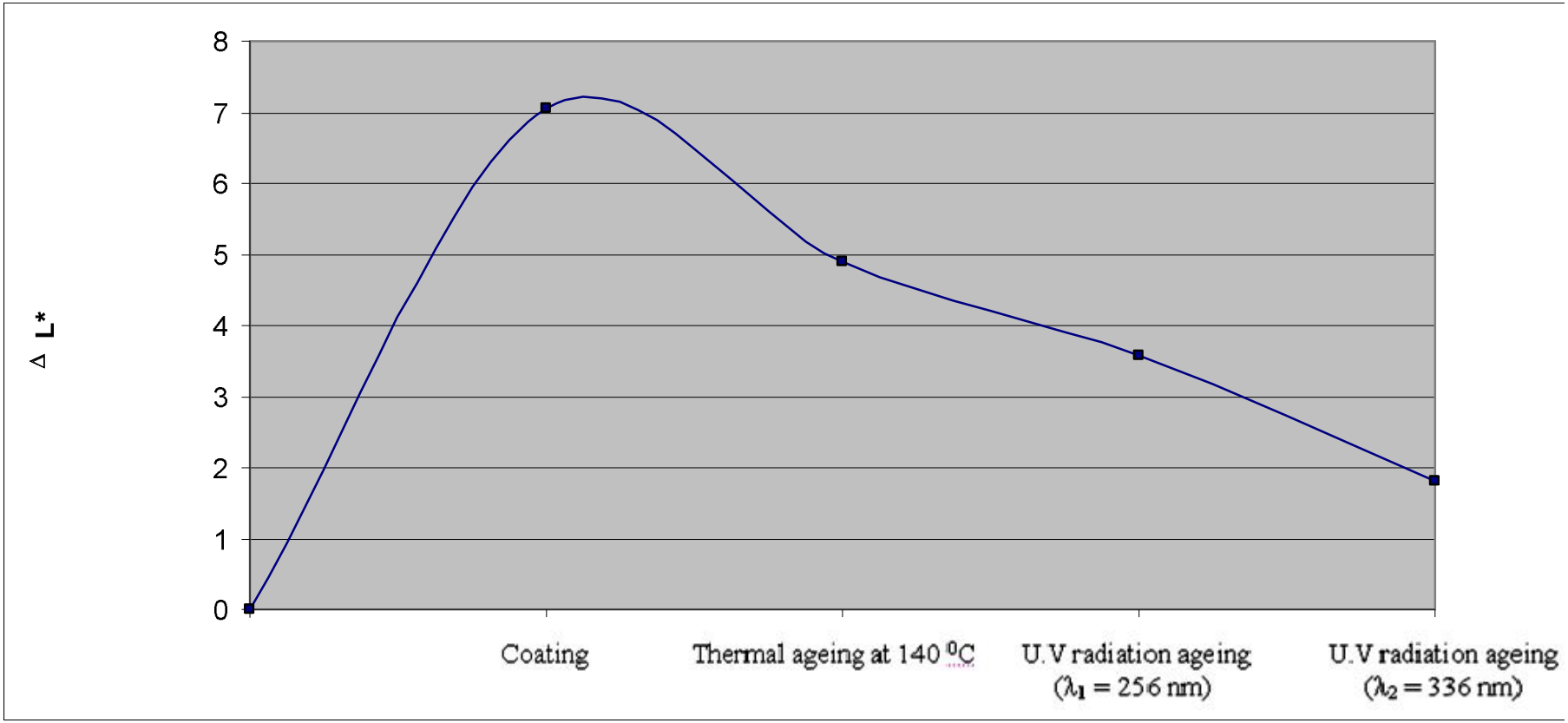

Figure 38: ΔL value of banknote paper (Egyptian 5 pounds "EGP") coated by 2nd L of (0.1%) Carboxymethyl cellulose (CMC) before and after ageing either by thermal ageing at 140 ^{0}C or by UV radiation (λ_1= 256 nm, λ_2 = 336 nm).*

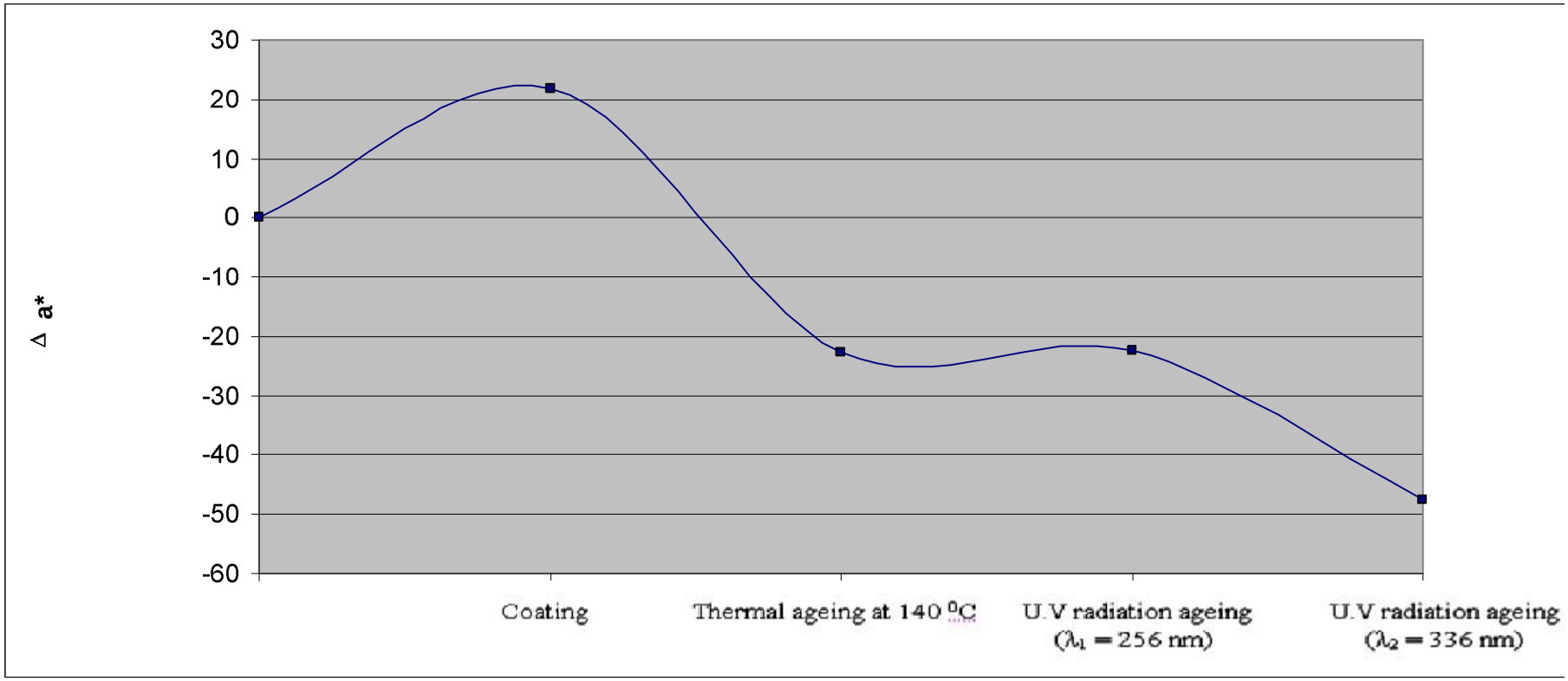

Figure 39: Δa value of banknote paper (Egyptian 5 pounds "EGP") coated by 2nd L of (0.1%) Carboxymethyl cellulose (CMC) before and after ageing either by thermal ageing at 140 ^{0}C or by UV radiation (λ_1= 256 nm, λ_2 = 336 nm).*

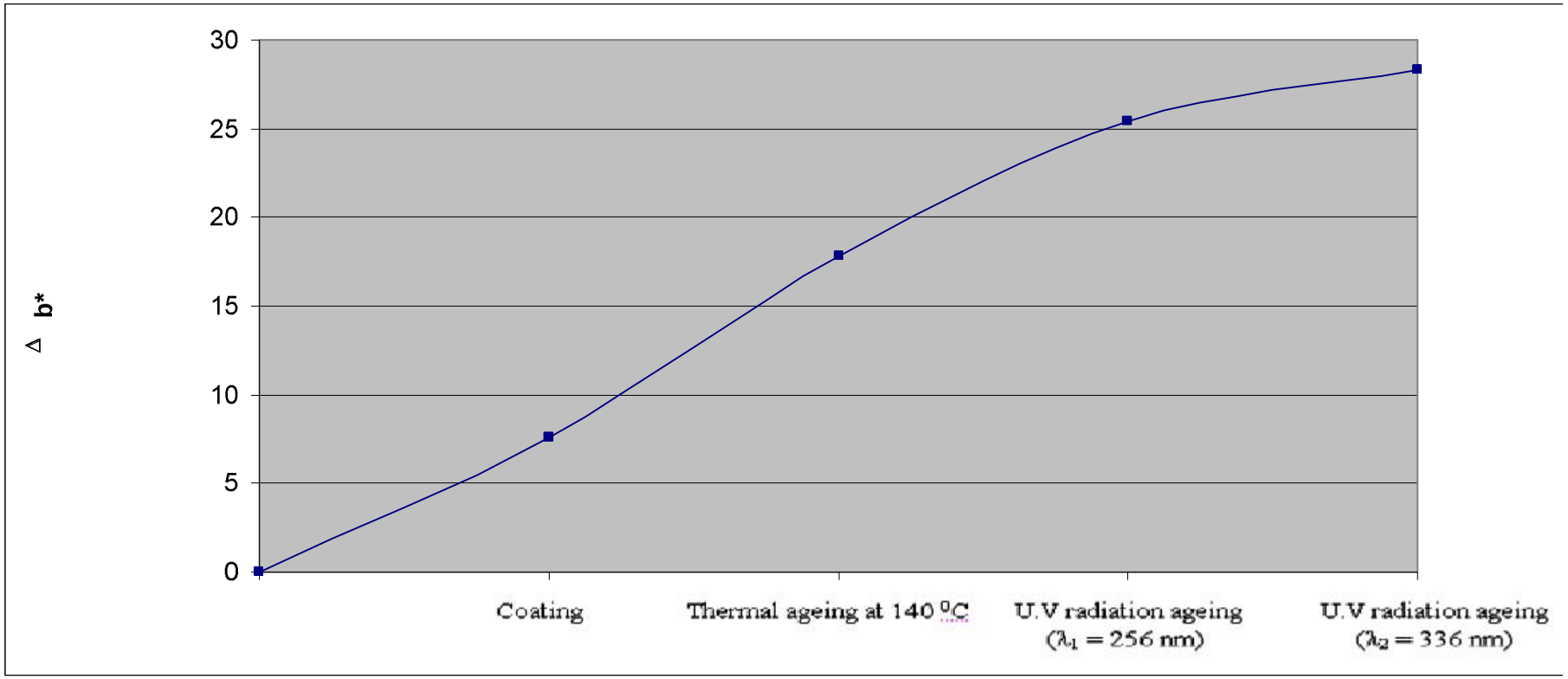

Figure 40: Δb value of banknote paper (Egyptian 5 pounds "EGP") coated by 2nd L of (0.1%) Carboxymethyl cellulose (CMC) before and after ageing either by thermal ageing at 140 ^{0}C or by UV radiation (λ_1= 256 nm, λ_2 = 336 nm).*

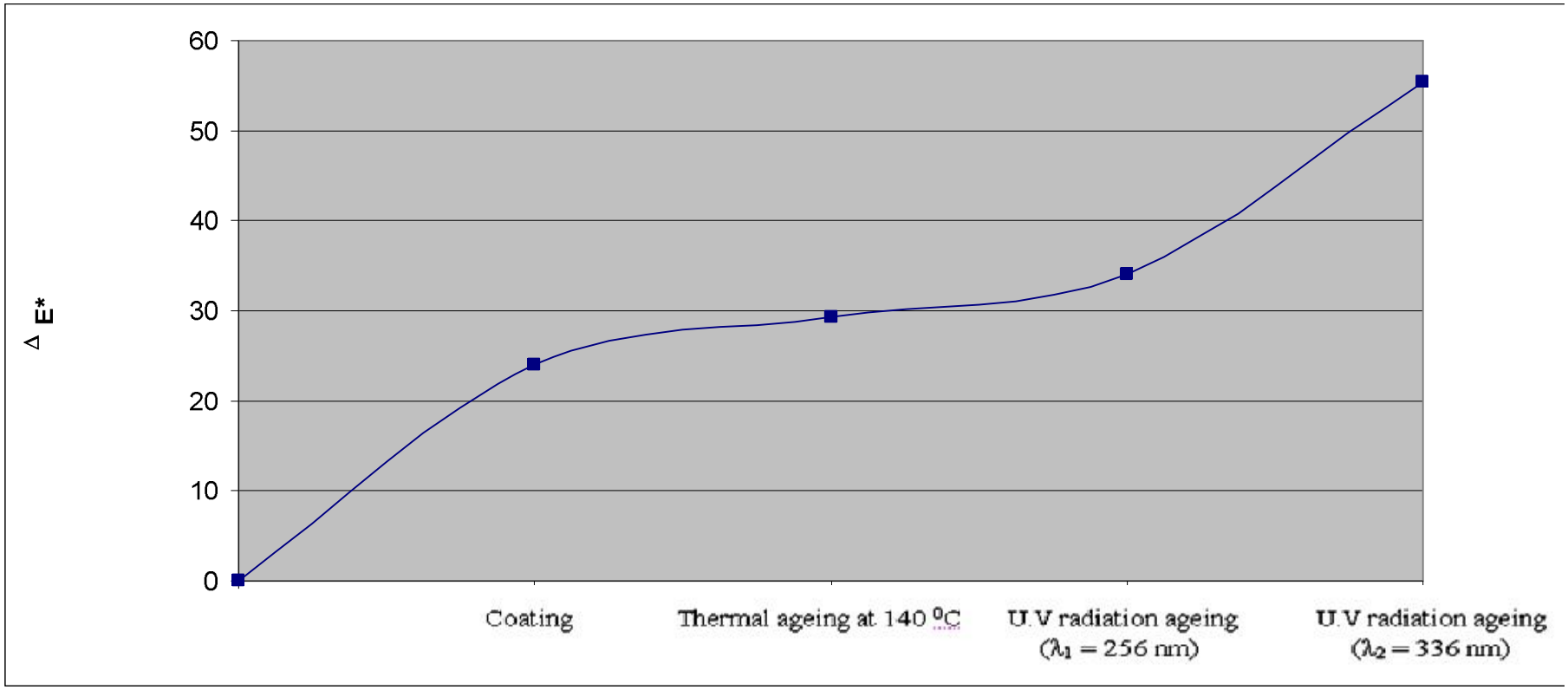

Figure 41: ΔE value of banknote paper (Egyptian 5 pounds "EGP") coated by 2nd L of (0.1%) Carboxymethyl cellulose (CMC) before and after ageing either by thermal ageing at 140 ^{0}C or by UV radiation (λ_1= 256 nm, λ_2 = 336 nm).*

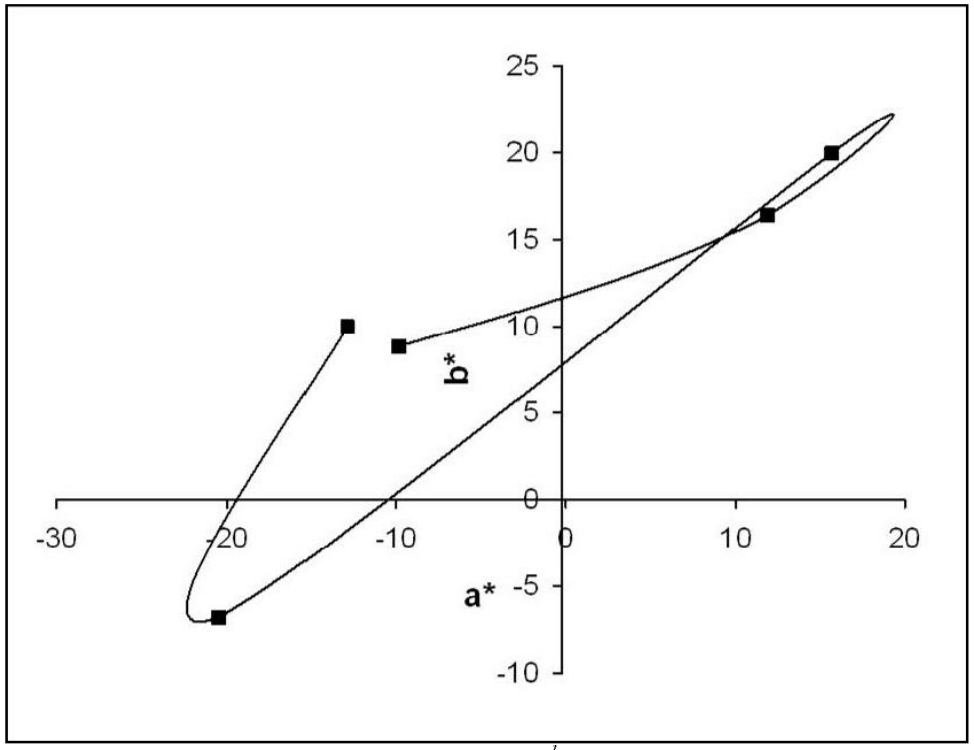

Figure 42: Effect of coating banknote paper (Egyptian 5 pounds "EGP") by 2nd L of (0.1%) Carboxymethyl cellulose (CMC) before and after ageing either by thermal ageing at 140 ^{0}C or by UV radiation (λ_1= 256 nm, λ_2 = 336 nm) on color change.

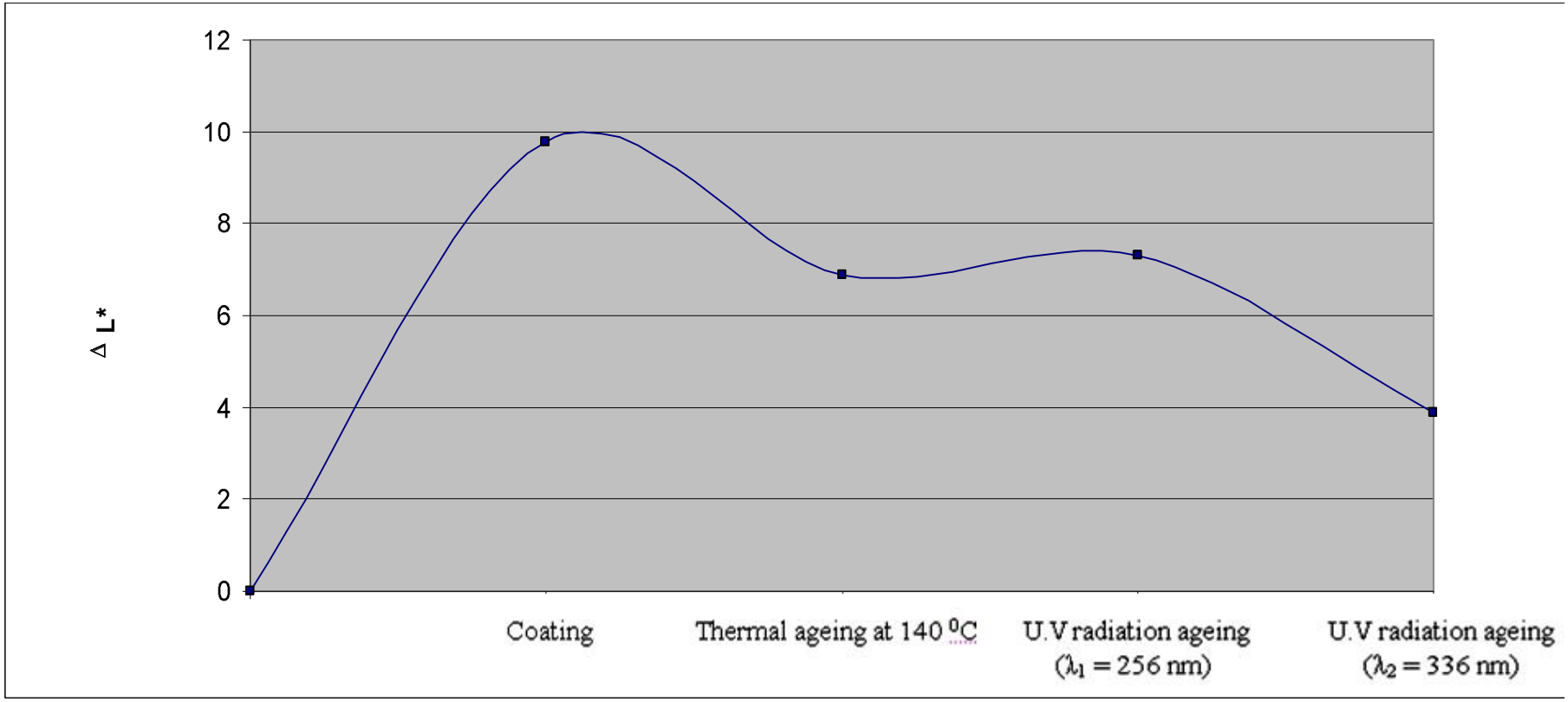

*Figure 43: ΔL*value of banknote paper (Egyptian 5 pounds "EGP") coated by 2nd L of (1%) Carboxymethyl cellulose (CMC) before and after ageing either by thermal ageing at 140 ^{0}C or by UV radiation (λ_1= 256 nm, λ_2 = 336 nm).*

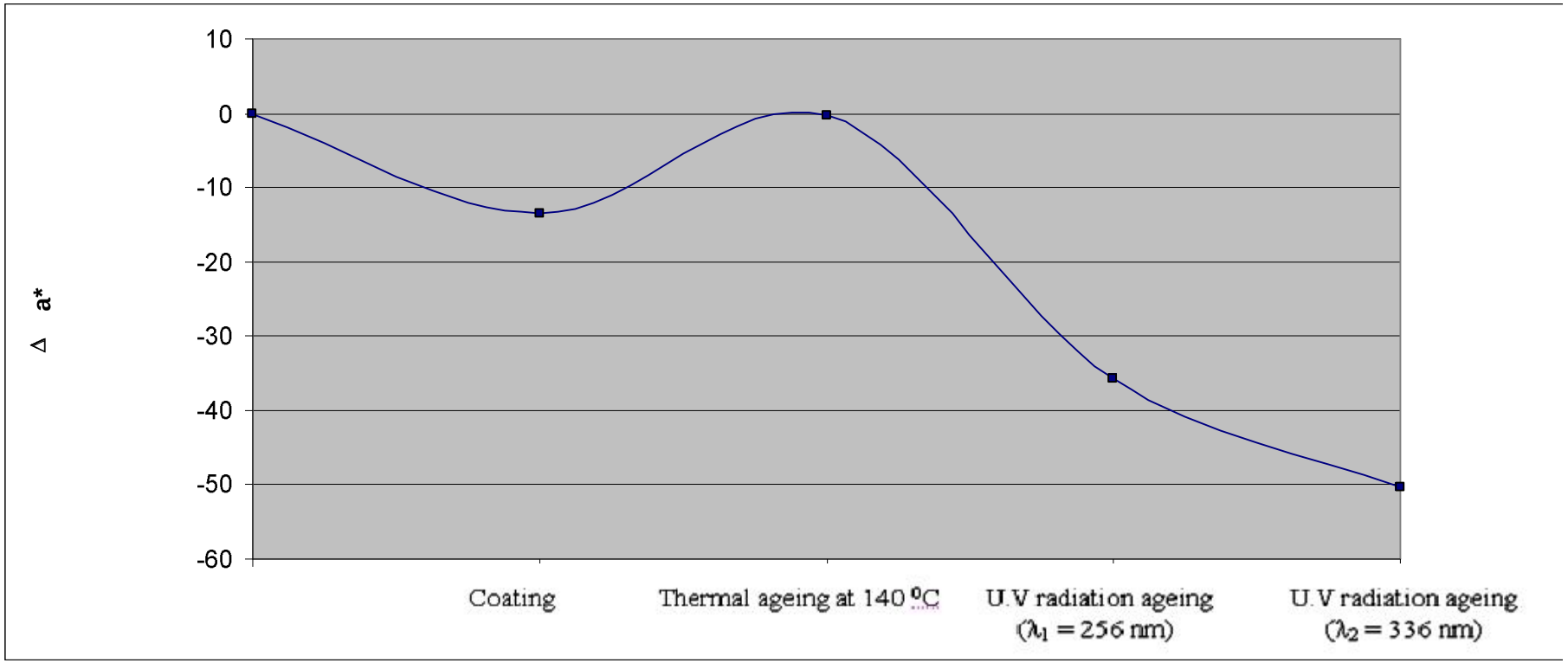

*Figure 44: Δa*value of banknote paper (Egyptian 5 pounds "EGP") coated by 2nd L of (1%) Carboxymethyl cellulose (CMC) before and after ageing either by thermal ageing at 140 ^{0}C or by UV radiation (λ_1= 256 nm, λ_2 = 336 nm).*

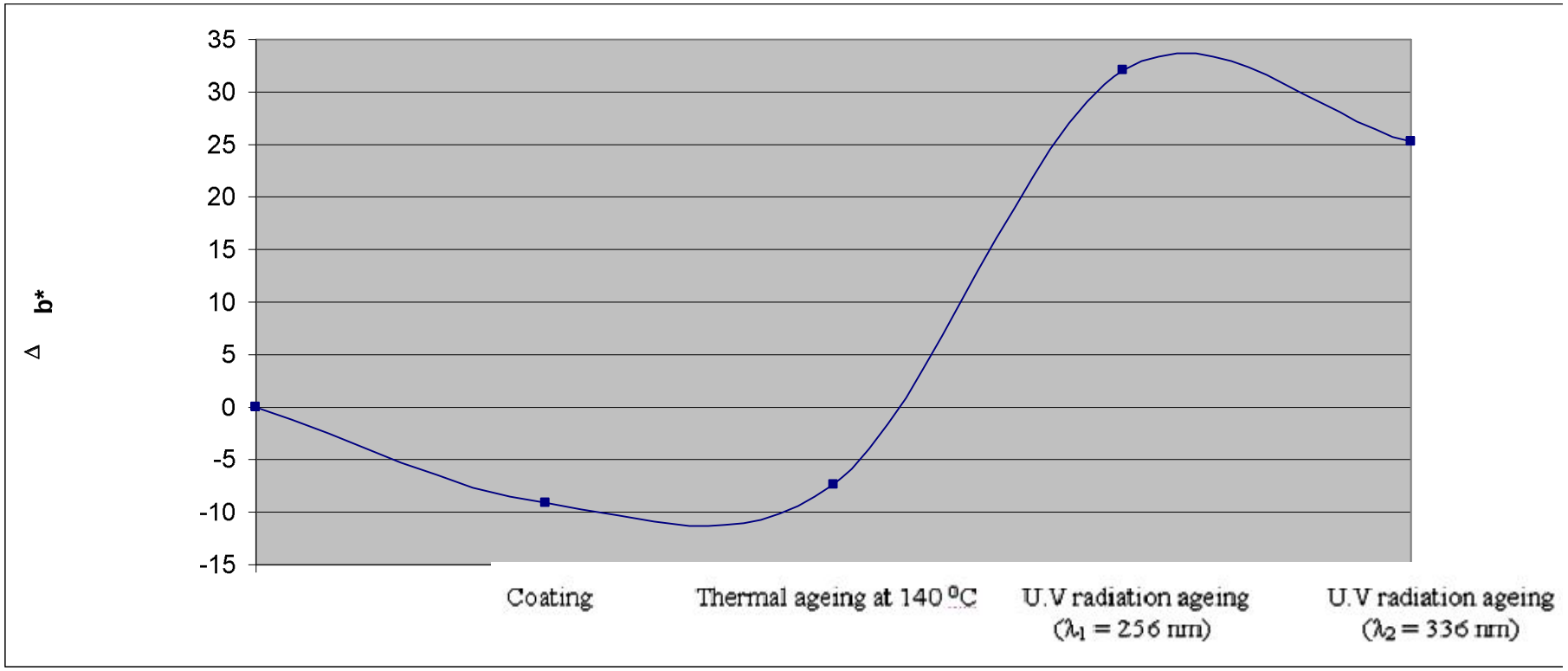

*Figure 45: Δb*value of banknote paper (Egyptian 5 pounds "EGP") coated by 2nd L of (1%) Carboxymethyl cellulose (CMC) before and after ageing either by thermal ageing at 140 ^{0}C or by UV radiation (λ_1= 256 nm, λ_2 = 336 nm).*

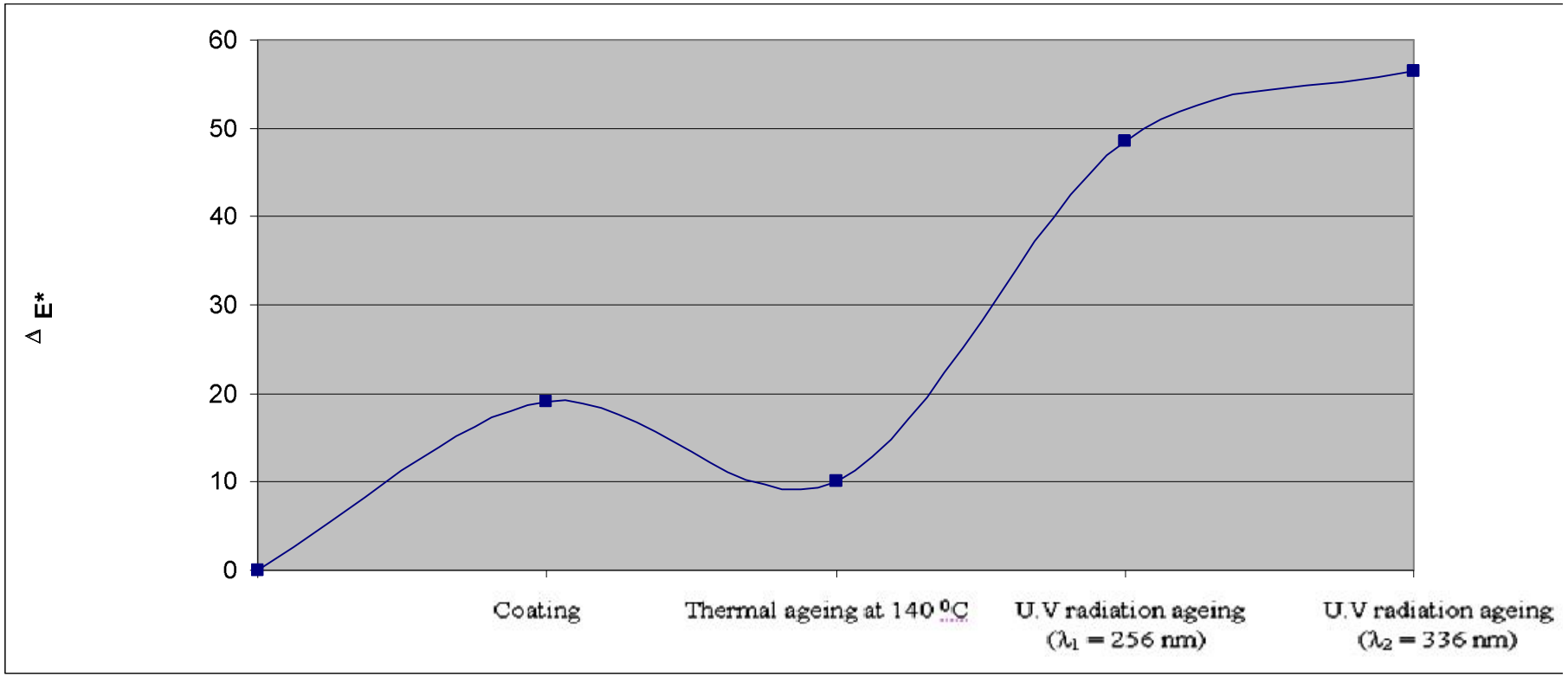

*Figure 46: ΔE*value of banknote paper (Egyptian 5 pounds "EGP") coated by 2nd L of (1%) Carboxymethyl cellulose (CMC) before and after ageing either by thermal ageing at 140 ^{0}C or by UV radiation (λ_1= 256 nm, λ_2 = 336 nm).*

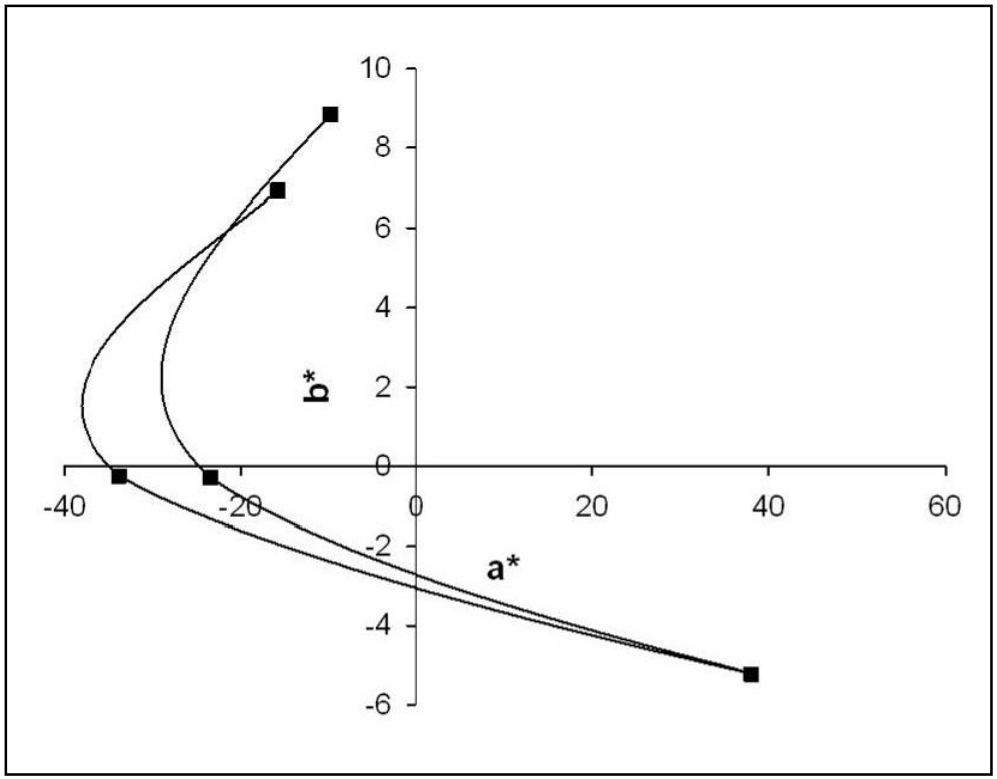

Figure 47 : Effect of coating banknote paper (Egyptian 5 pounds "EGP") by 2nd L of (1%) Carboxymethyl cellulose (CMC) before and after ageing either by thermal ageing at 140 ^{0}C or by UV radiation (λ_1= 256 nm, λ_2 = 336 nm) on color change.

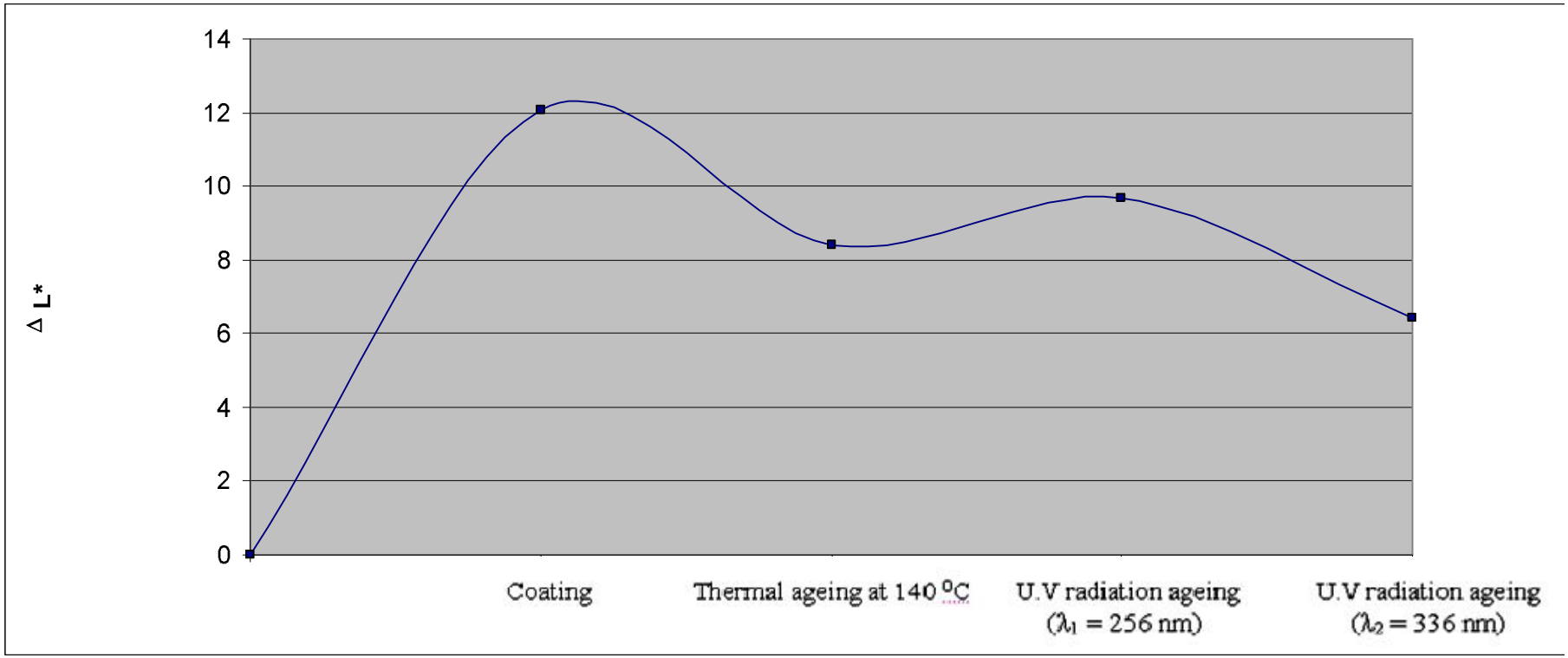

Figure 48: ΔL value of banknote paper (Egyptian 5 pounds "EGP") coated by 3rd L of (0.1%) Carboxymethyl cellulose (CMC) before and after ageing either by thermal ageing at 140 ^{0}C or by UV radiation (λ_1= 256 nm, λ_2 = 336 nm).*

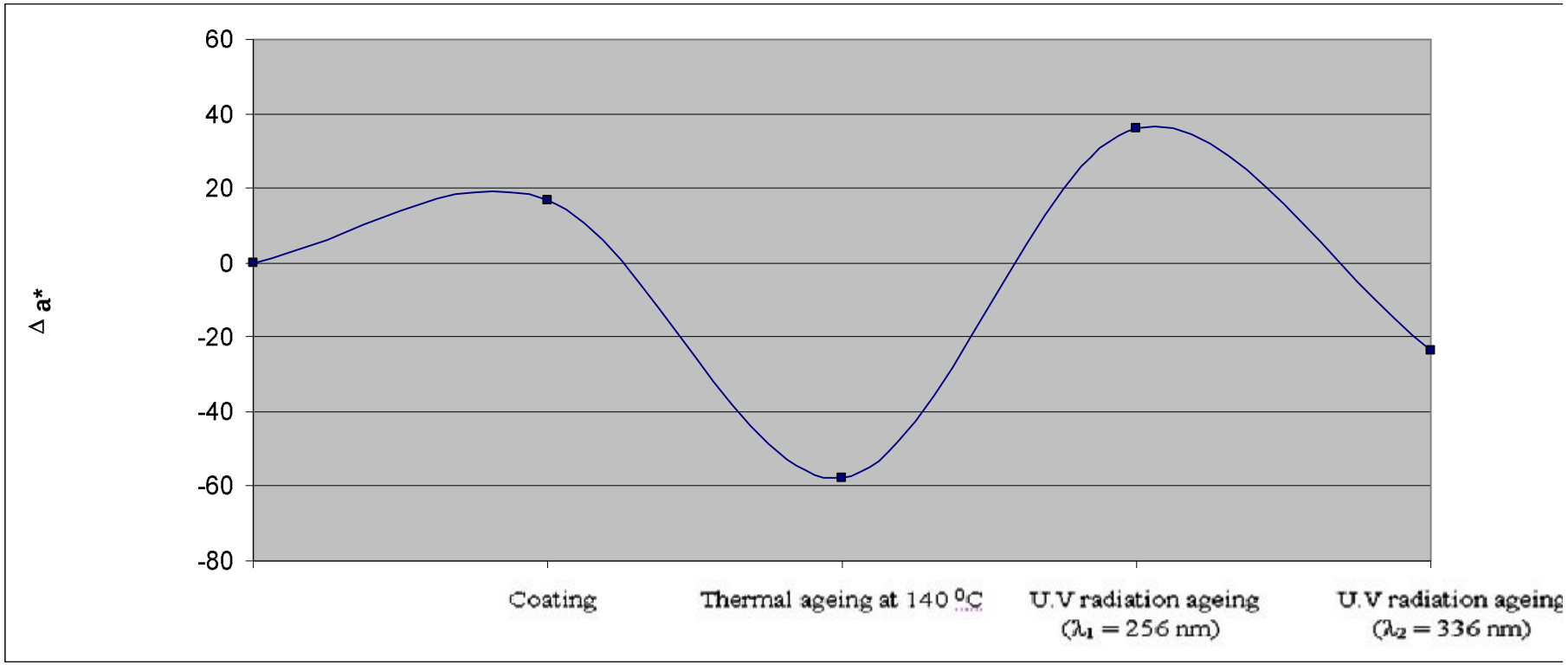

Figure 49: Δa value of banknote paper (Egyptian 5 pounds "EGP") coated by 3rd L of (0.1%) Carboxymethyl cellulose (CMC) before and after ageing either by thermal ageing at 140 ^{0}C or by UV radiation (λ_1= 256 nm, λ_2 = 336 nm).*

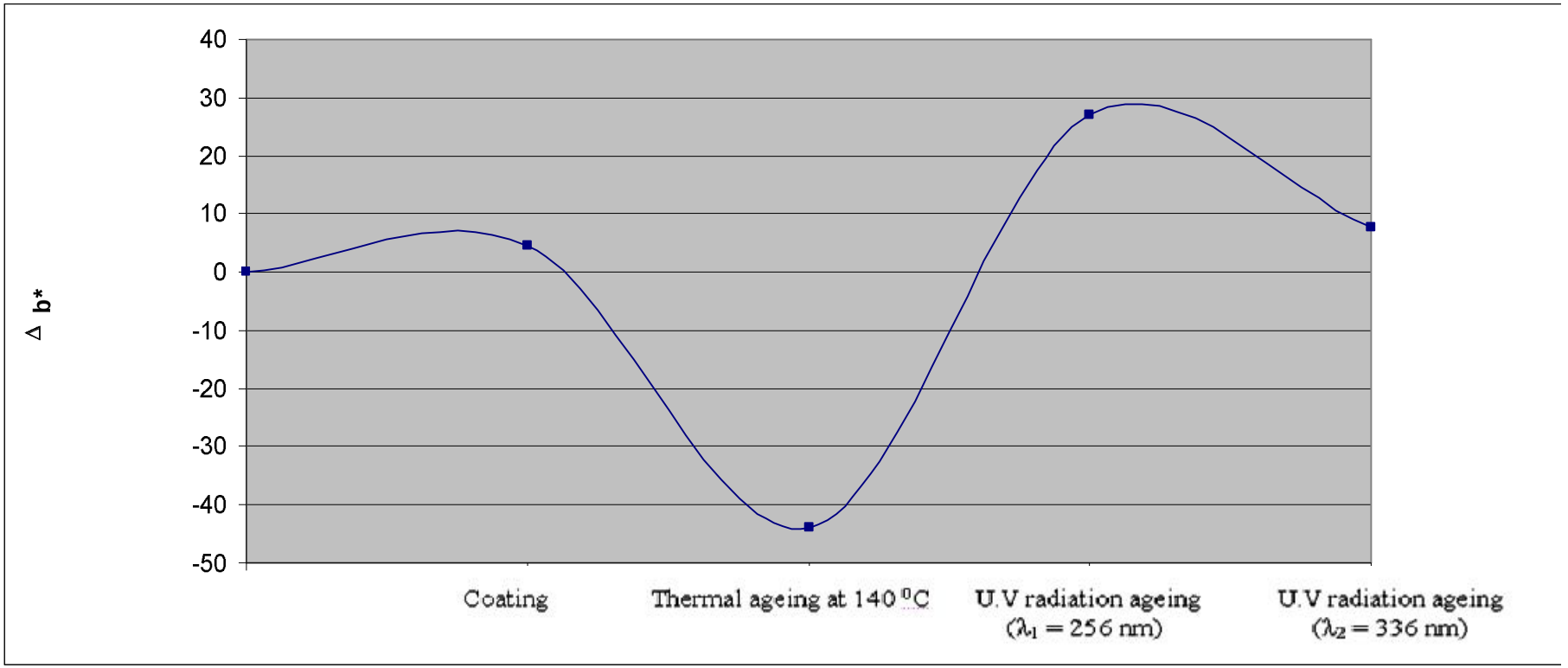

Figure 50: Δb value of banknote paper (Egyptian 5 pounds "EGP") coated by 3rd L of (0.1%) Carboxymethyl cellulose (CMC) before and after ageing either by thermal ageing at 140 ^{0}C or by UV radiation (λ_1= 256 nm, λ_2 = 336 nm).*

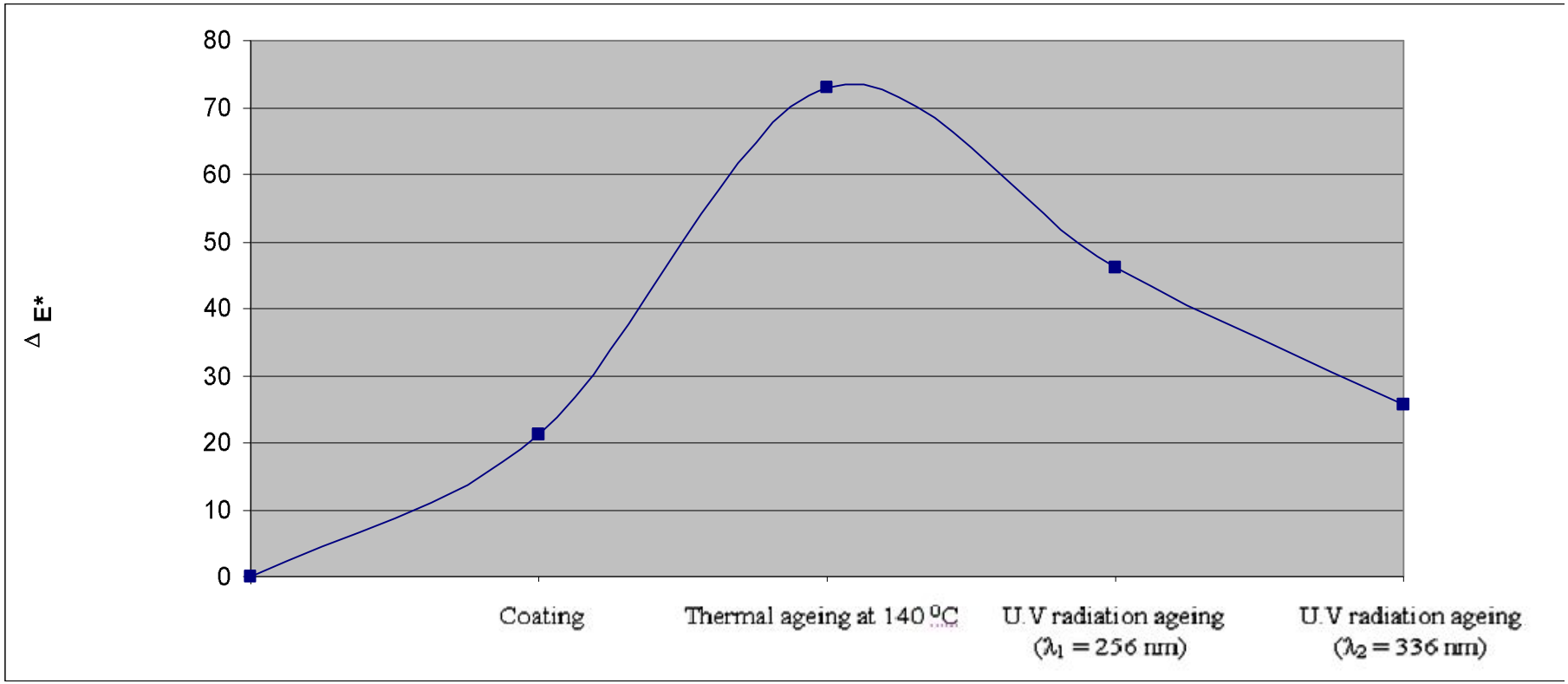

Figure 51: ΔE value of banknote paper (Egyptian 5 pounds "EGP") coated by 3rd L of (0.1%) Carboxymethyl cellulose (CMC) before and after ageing either by thermal ageing at 140 ^{0}C or by UV radiation (λ_1= 256 nm, λ_2 = 336 nm).*

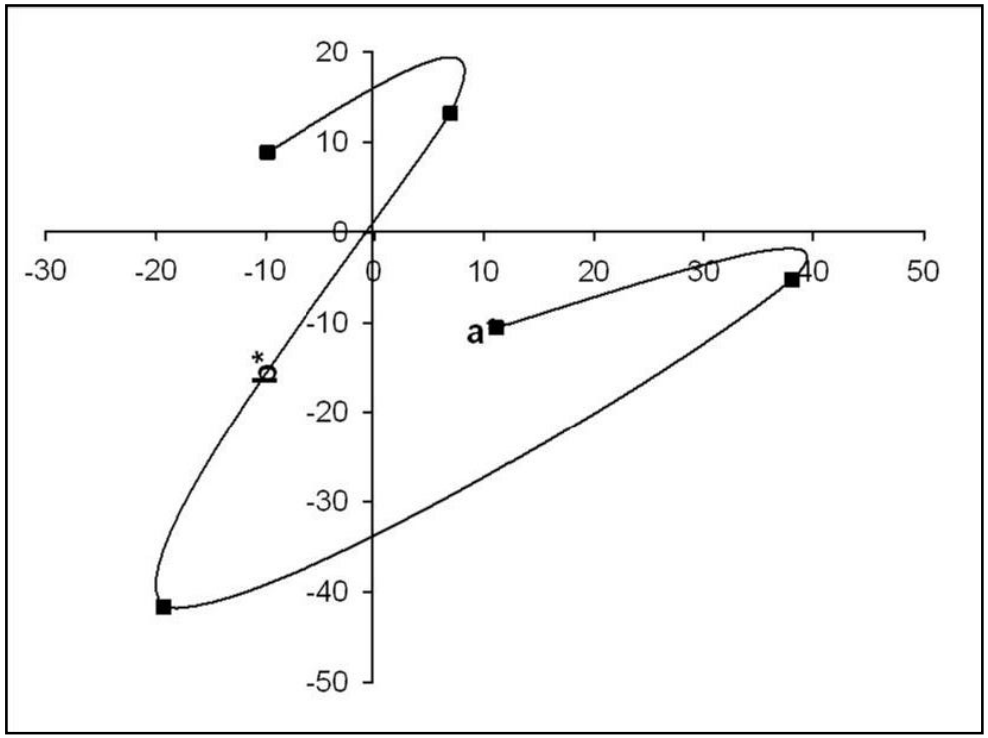

Figure 52: Effect of coating banknote paper (Egyptian 5 pounds "EGP") by 3rd L of (0.1%) Carboxymethyl cellulose (CMC) before and after ageing either by thermal ageing at 140 ^{0}C or by UV radiation (λ_1= 256 nm, λ_2 = 336 nm) on color change.

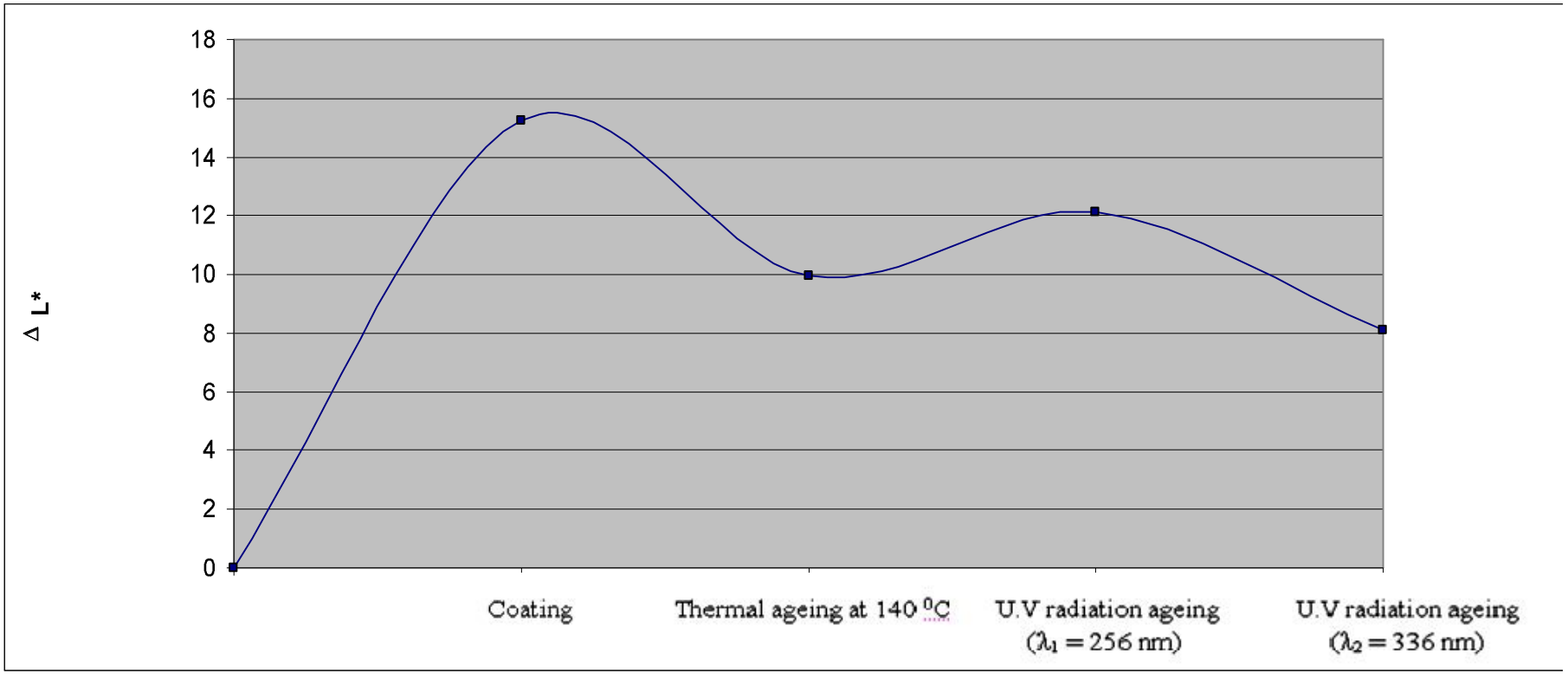

Figure 53: ΔL value of banknote paper (Egyptian 5 pounds "EGP") coated by 3rd L of (1%) Carboxymethyl cellulose (CMC) before and after ageing either by thermal ageing at 140 ^{0}C or by UV radiation (λ_1= 256 nm, λ_2 = 336 nm).*

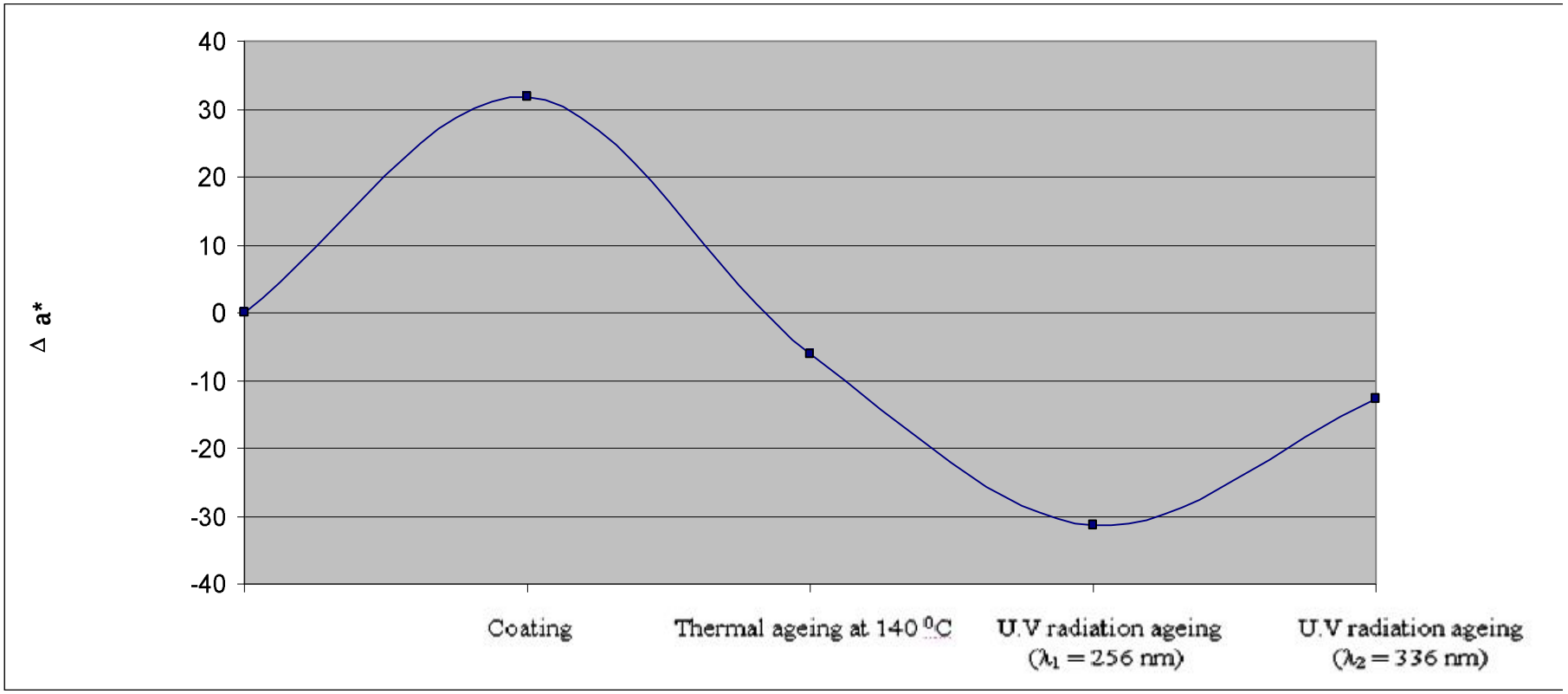

Figure 54: Δa value of banknote paper (Egyptian 5 pounds "EGP") coated by 3rd L of (1%) Carboxymethyl cellulose (CMC) before and after ageing either by thermal ageing at 140 ^{0}C or by UV radiation (λ_1= 256 nm, λ_2 = 336 nm).*

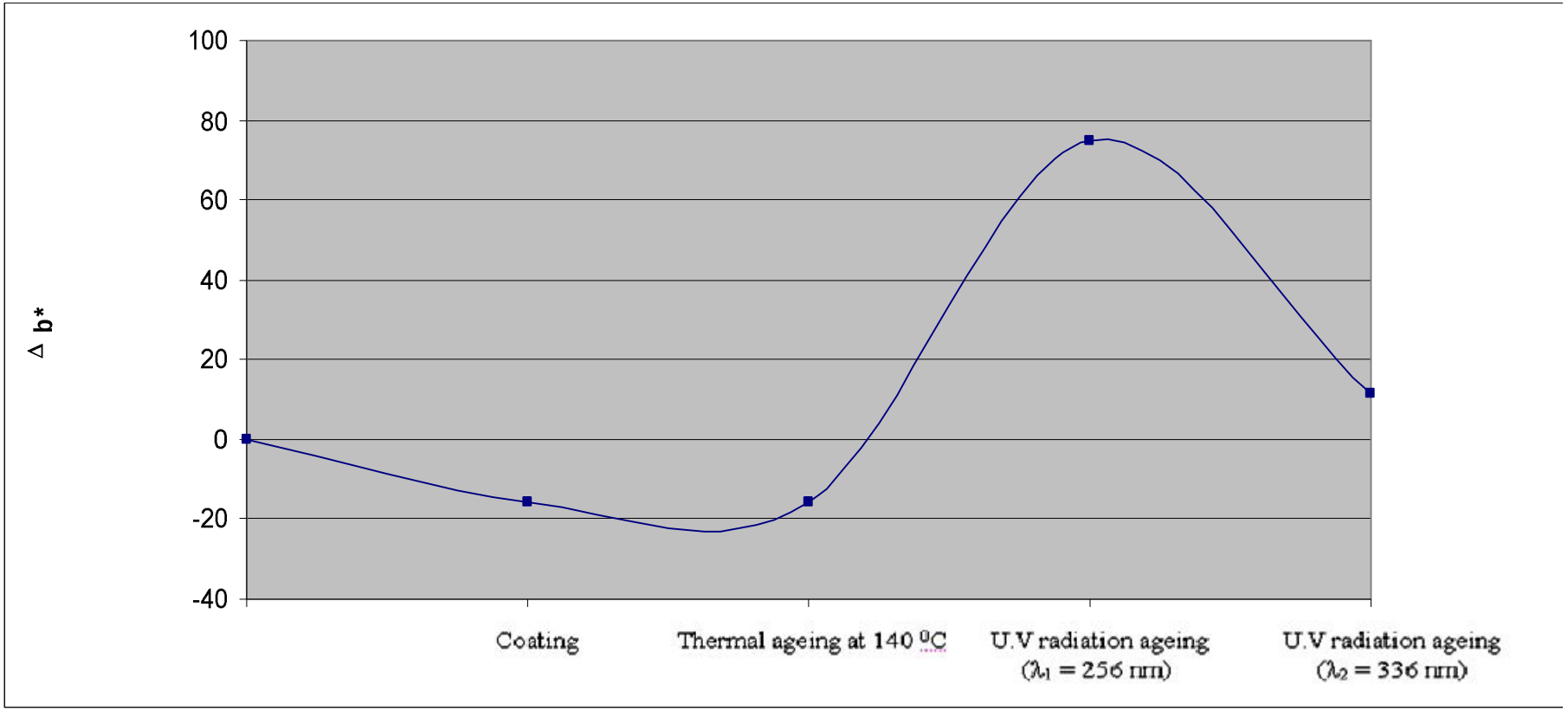

Figure 55: Δb value of banknote paper (Egyptian 5 pounds "EGP") coated by 3rd L of (1%) Carboxymethyl cellulose (CMC) before and after ageing either by thermal ageing at 140 ^{0}C or by UV radiation (λ_1= 256 nm, λ_2 = 336 nm).*

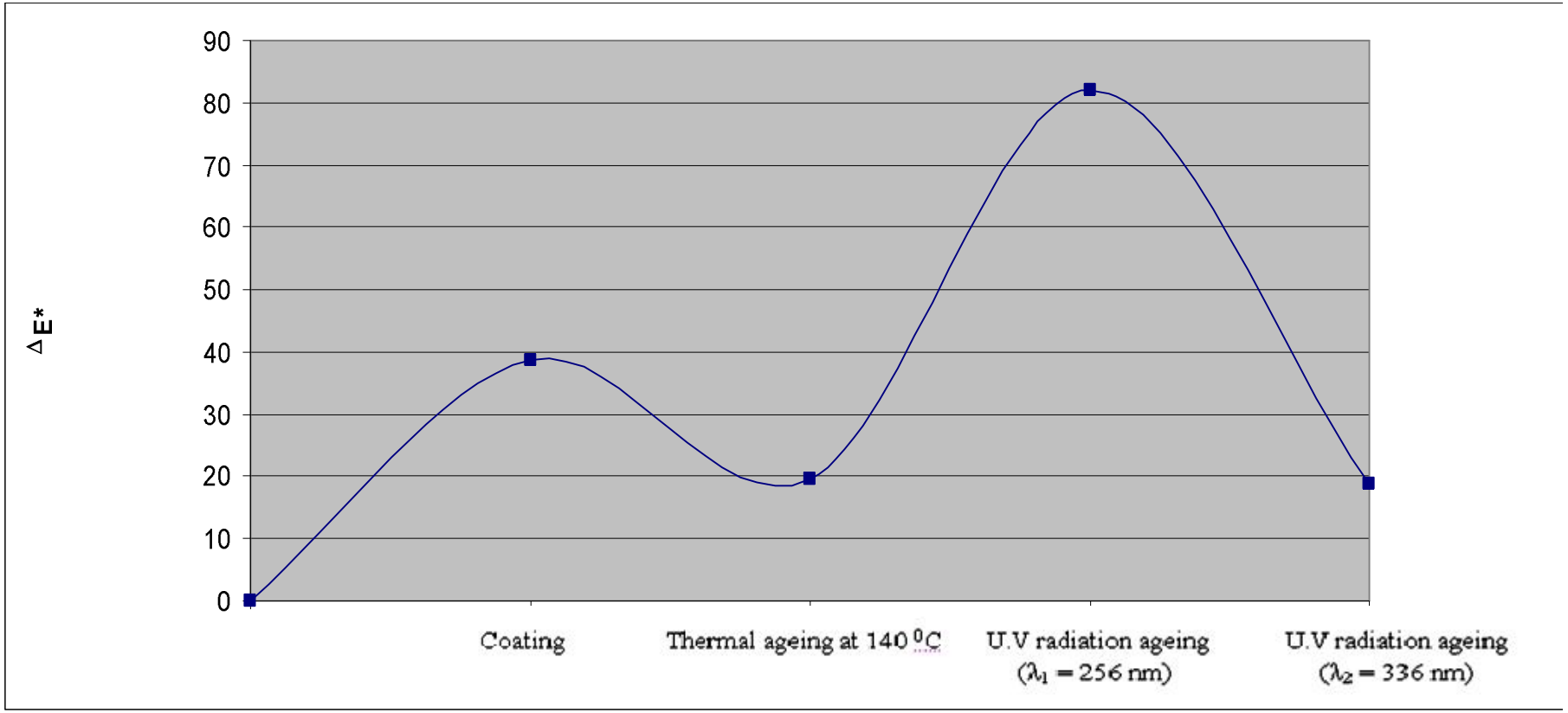

Figure 56: ΔE value of banknote paper (Egyptian 5 pounds "EGP") coated by 3rd L of (1%) Carboxymethyl cellulose (CMC) before and after ageing either by thermal ageing at 140 ^{0}C or by UV radiation (λ_1= 256 nm, λ_2 = 336 nm).*

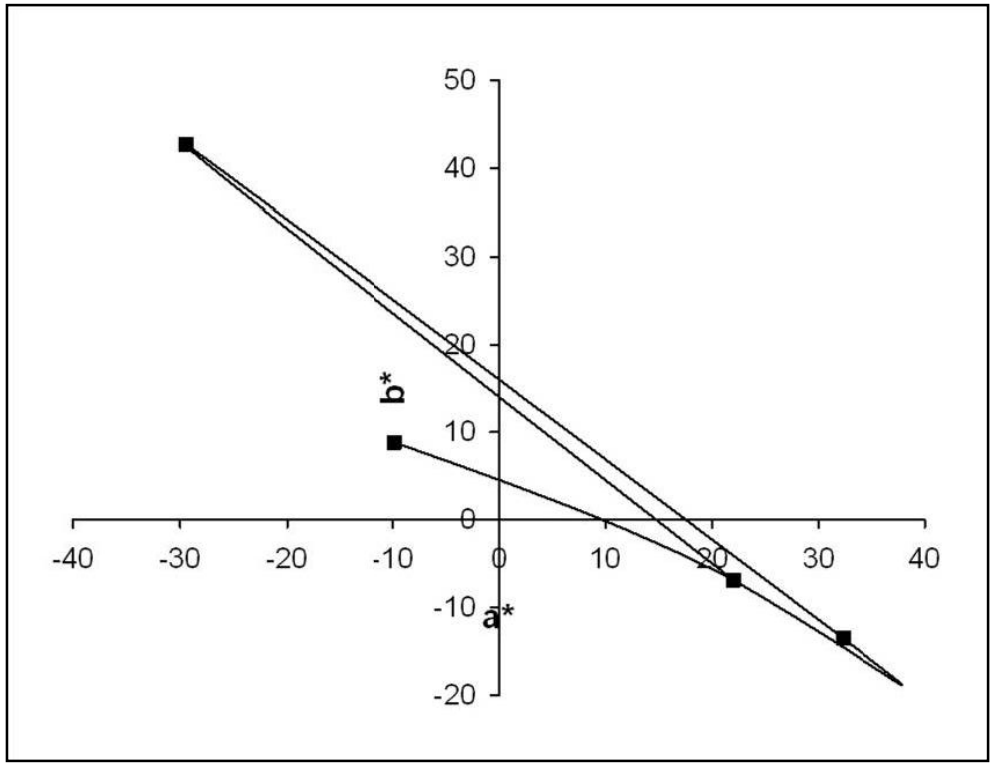

Figure 57: Effect of coating banknote paper (Egyptian 5 pounds "EGP") by 3rd L of (1%) Carboxymethyl cellulose (CMC) before and after ageing either by thermal ageing at 140 ^{0}C or by UV radiation (λ_1= 256 nm, λ_2 = 336 nm) on color change.

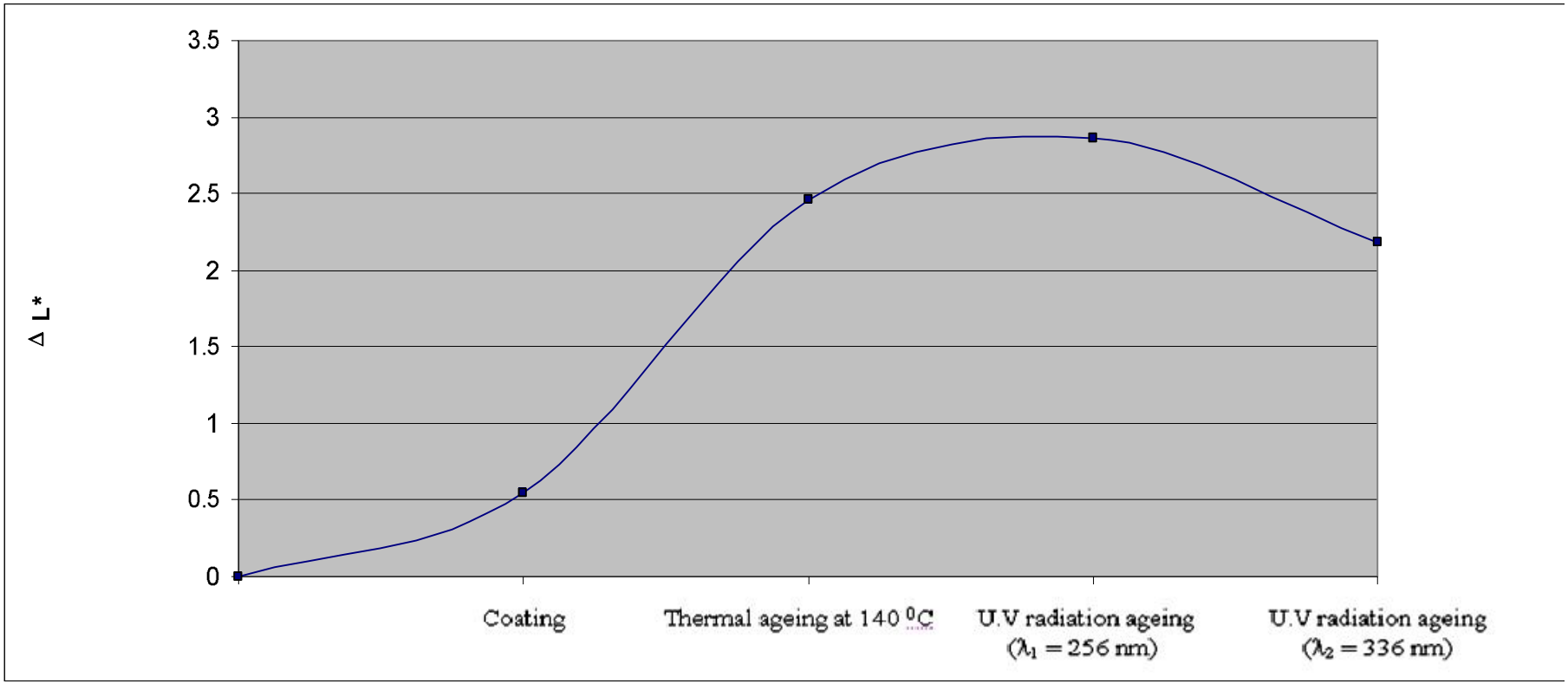

Figure 58: ΔL value of banknote paper (Egyptian 10 pounds "EGP") coated by 1st L of (0.1%) Carboxymethyl cellulose (CMC) before and after ageing either by thermal ageing at 140 ^{0}C or by UV radiation (λ_1= 256 nm, λ_2 = 336 nm).*

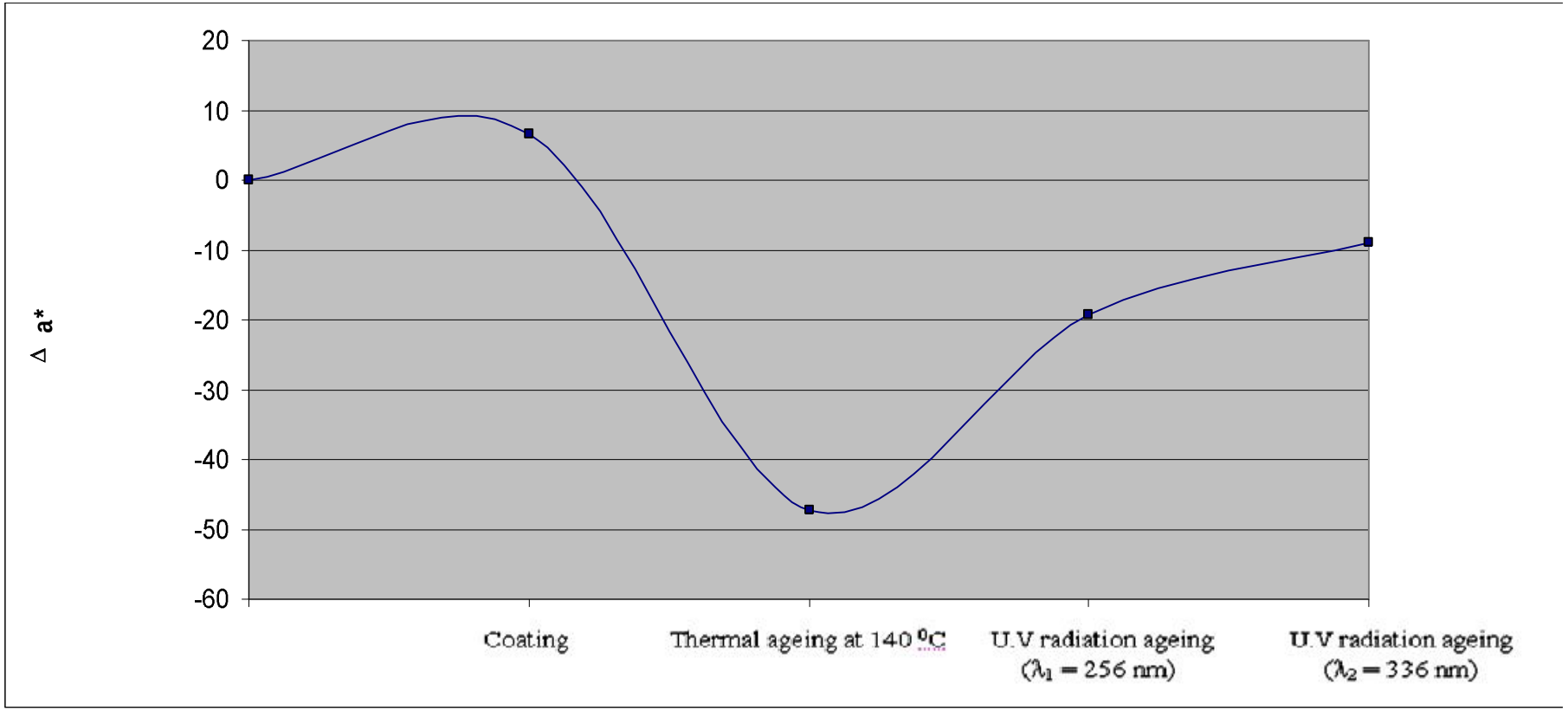

Figure 59: Δa value of banknote paper (Egyptian 10 pounds "EGP") coated by 1st L of (0.1%) Carboxymethyl cellulose (CMC) before and after ageing either by thermal ageing at 140 ^{0}C or by UV radiation (λ_1= 256 nm, λ_2 = 336 nm).*

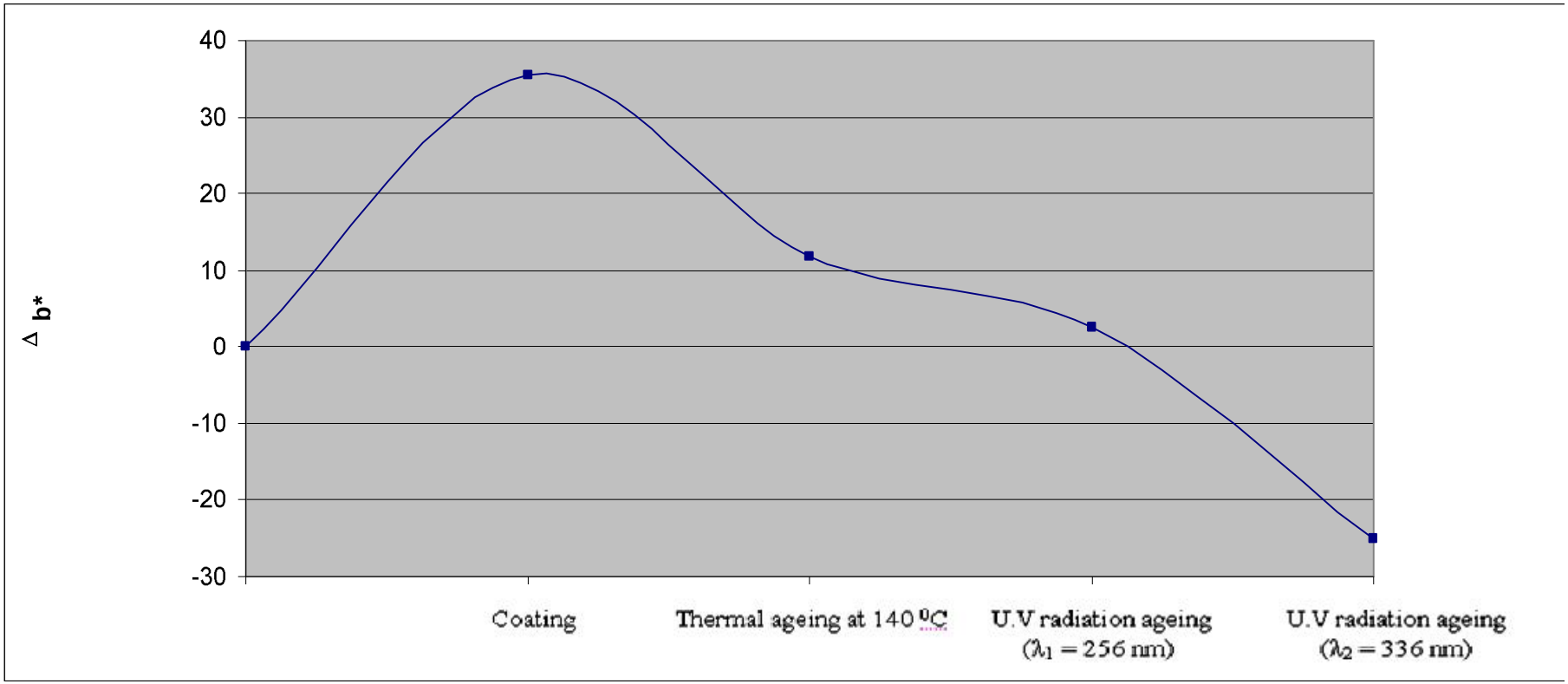

Figure 60: Δb value of banknote paper (Egyptian 10 pounds "EGP") coated by 1st L of (0.1%) Carboxymethyl cellulose (CMC) before and after ageing either by thermal ageing at 140 ^{0}C or by UV radiation (λ_1= 256 nm, λ_2 = 336 nm).*

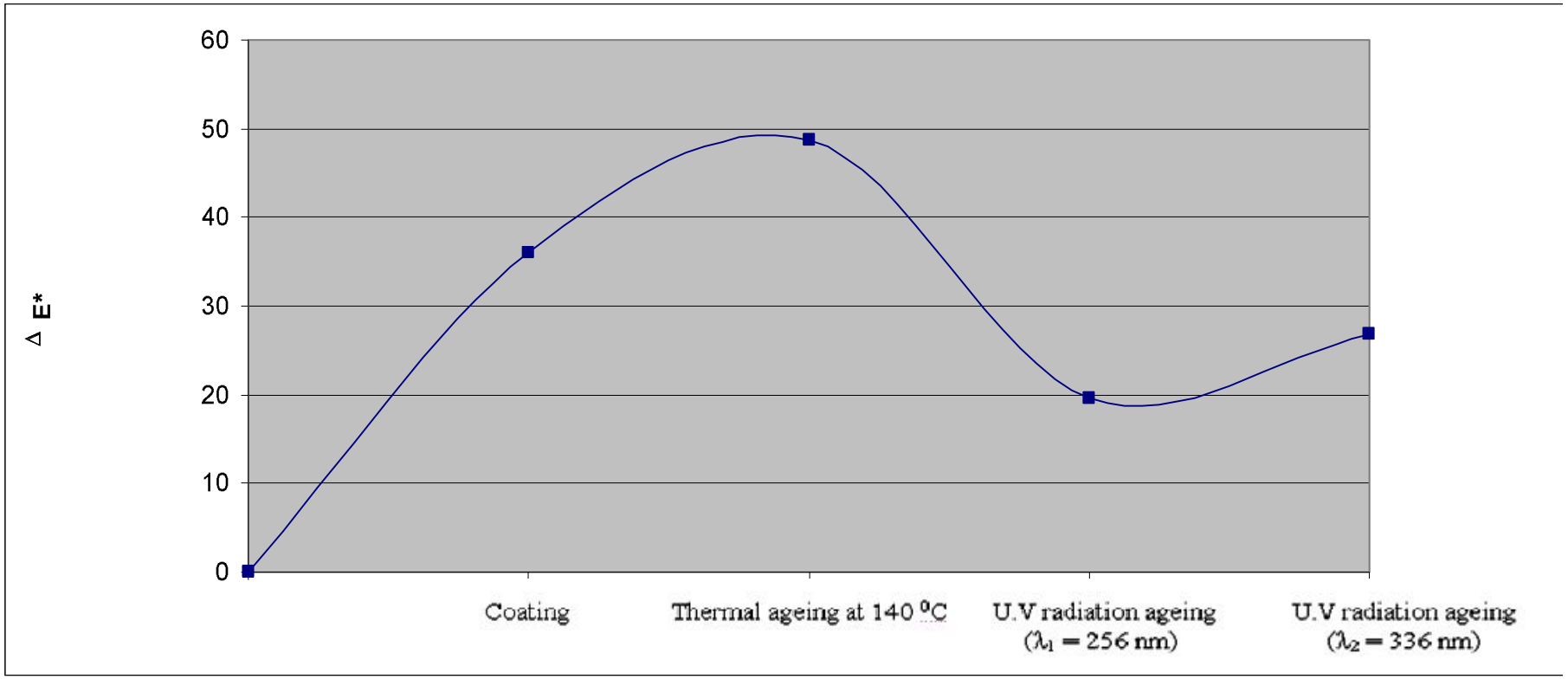

Figure 61: ΔE value of banknote paper (Egyptian 10 pounds "EGP") coated by 1st L of (0.1%) Carboxymethyl cellulose (CMC) before and after ageing either by thermal ageing at 140 ^{0}C or by UV radiation (λ_1= 256 nm, λ_2 = 336 nm).*

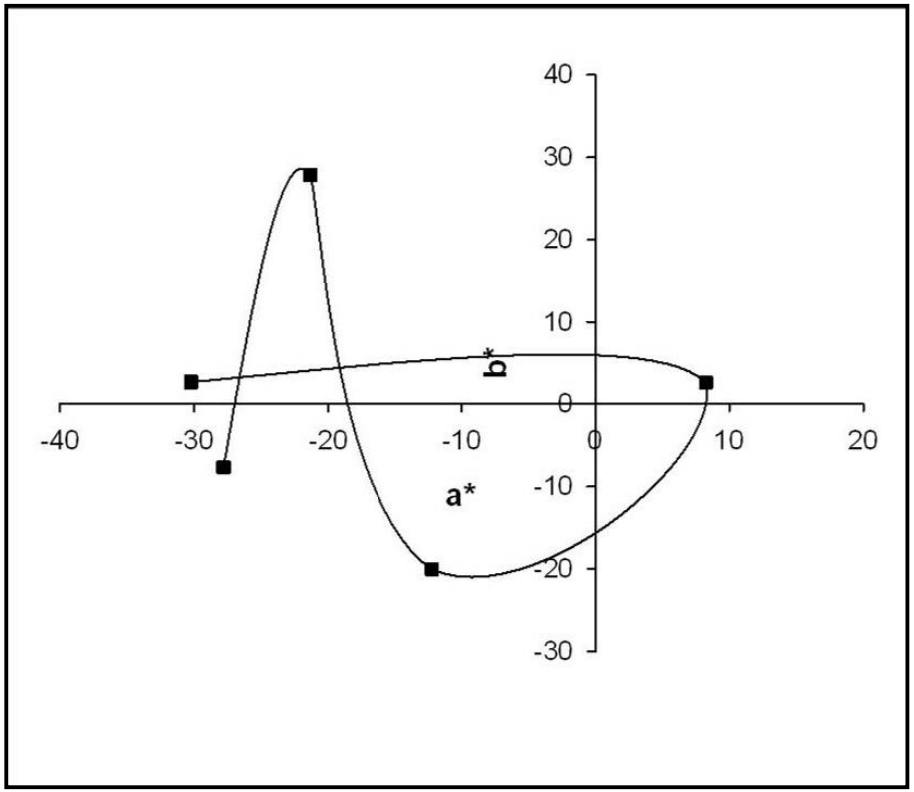

Figure 62: Effect of coating banknote paper (Egyptian 10 pounds "EGP") by 1st L of (0.1%) Carboxymethyl cellulose (CMC) before and after ageing either by thermal ageing at 140 ^{0}C or by UV radiation (λ_1= 256 nm, λ_2 = 336 nm) on color change.

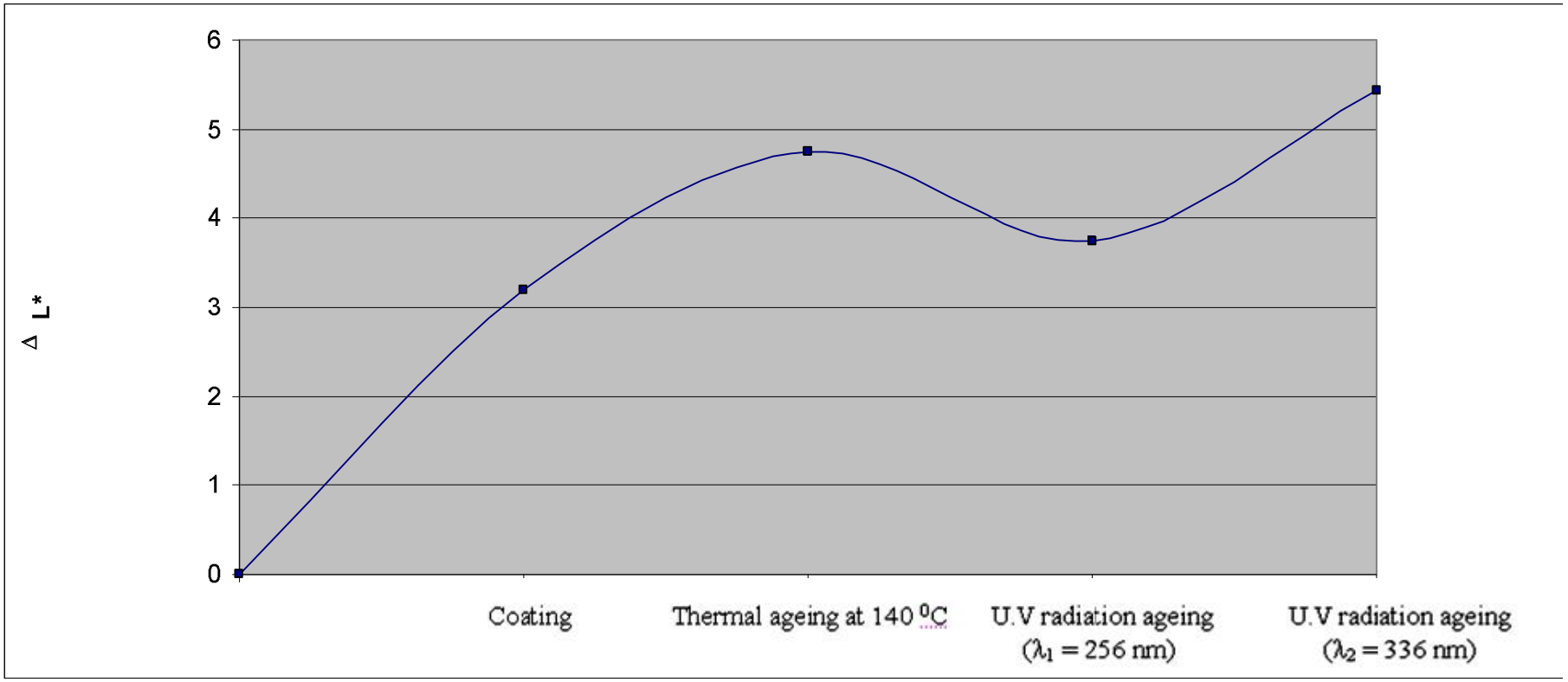

Figure 63: ΔL value of banknote paper (Egyptian 10 pounds "EGP") coated by 1st L of (1%) Carboxymethyl cellulose (CMC) before and after ageing either by thermal ageing at 140 ^{0}C or by UV radiation (λ_1= 256 nm, λ_2 = 336 nm).*

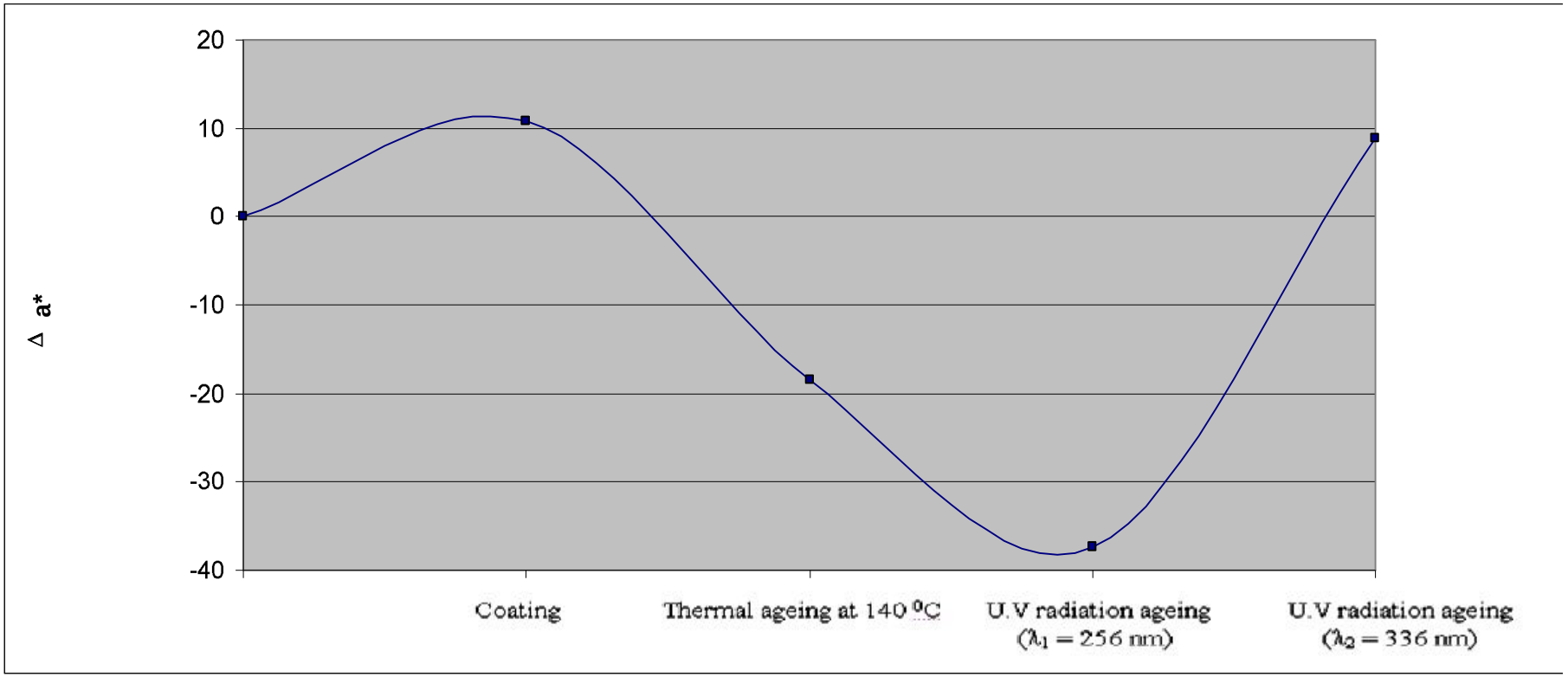

Figure 64: Δa value of banknote paper (Egyptian 10 pounds "EGP") coated by 1st L of (1%) Carboxymethyl cellulose (CMC) before and after ageing either by thermal ageing at 140 ^{0}C or by UV radiation (λ_1= 256 nm, λ_2 = 336 nm).*

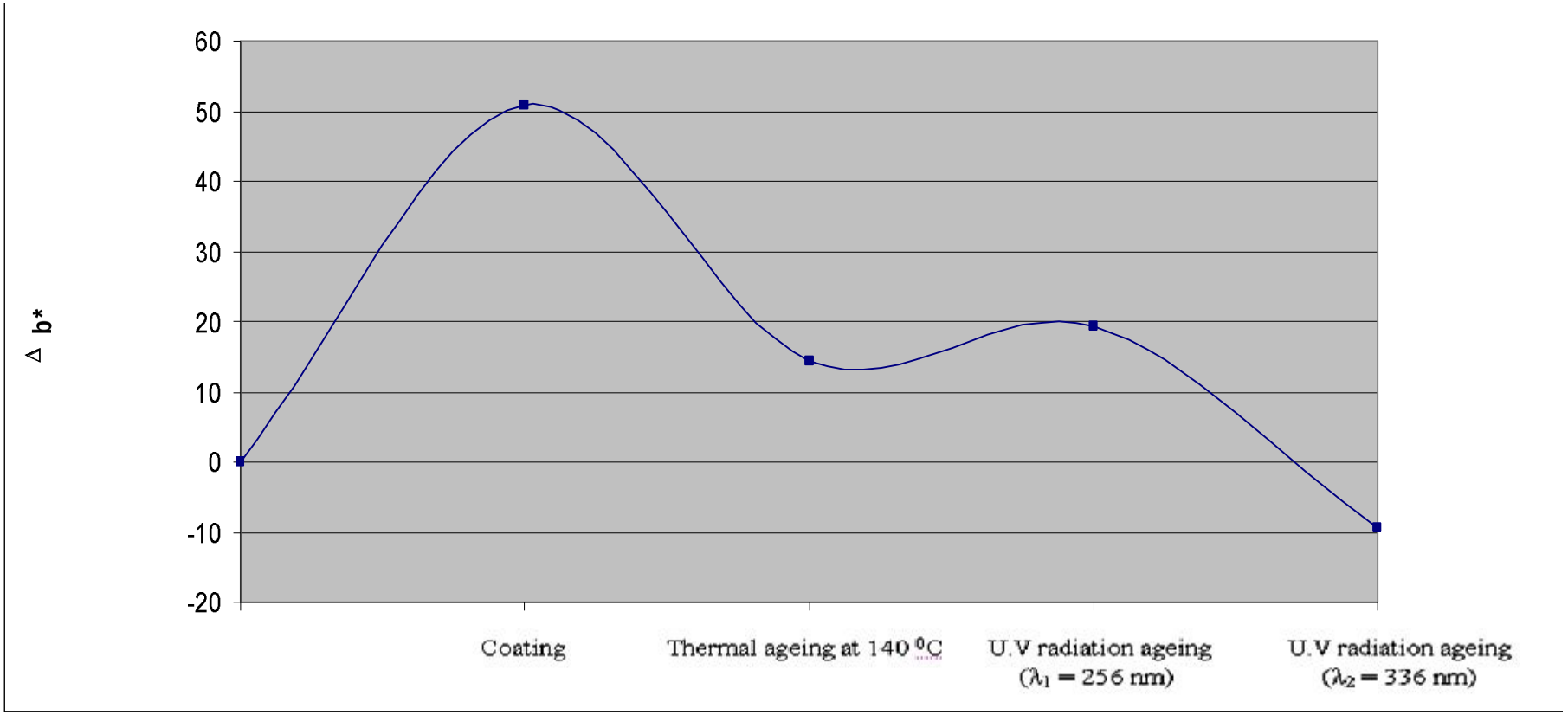

Figure 65: Δb value of banknote paper (Egyptian 10 pounds "EGP") coated by 1st L of (1%) Carboxymethyl cellulose (CMC) before and after ageing either by thermal ageing at 140 ^{0}C or by UV radiation (λ_1= 256 nm, λ_2 = 336 nm).*

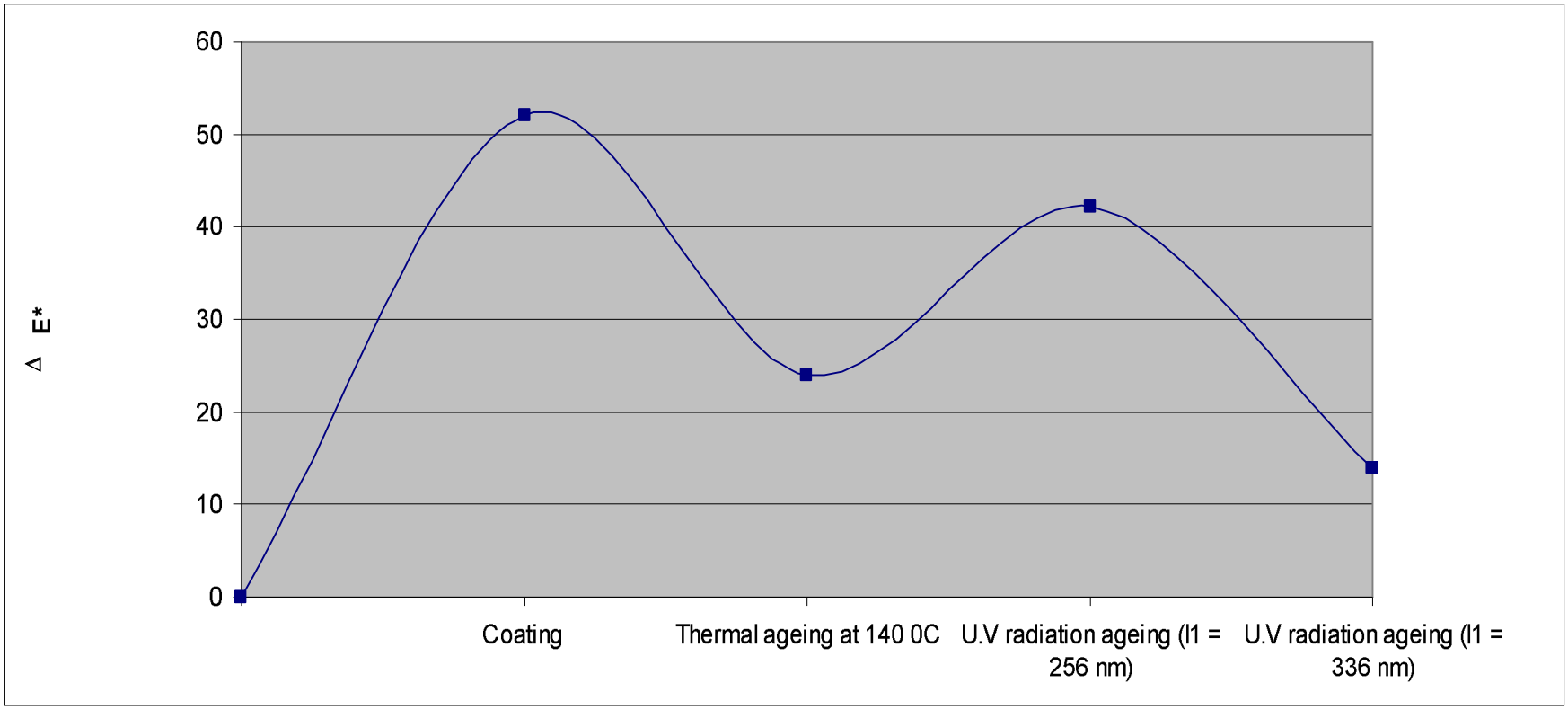

Figure 66: ΔE value of banknote paper (Egyptian 10 pounds "EGP") coated by 1st L of (1%) Carboxymethyl cellulose (CMC) before and after ageing either by thermal ageing at 140 ^{0}C or by UV radiation (λ_1= 256 nm, λ_2 = 336 nm).*

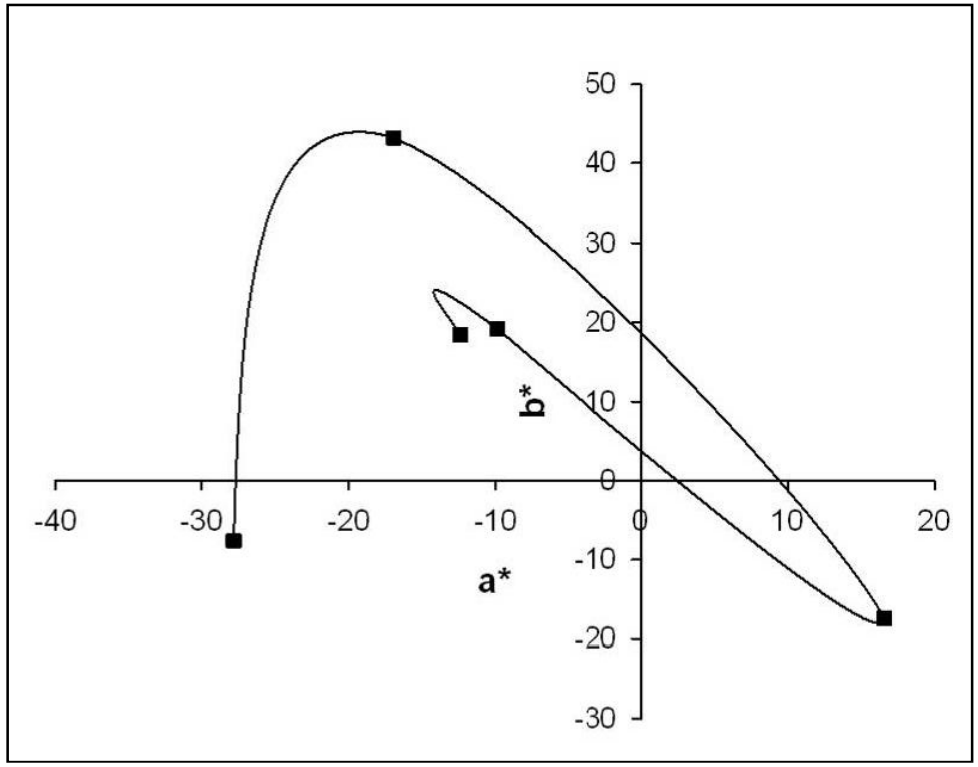

Figure 67: Effect of coating banknote paper (Egyptian 10 pounds "EGP") by 1st L of (1%) Carboxymethyl cellulose (CMC) before and after ageing either by thermal ageing at 140 ^{0}C or by UV radiation (λ_1= 256 nm, λ_2 = 336 nm) on color change.

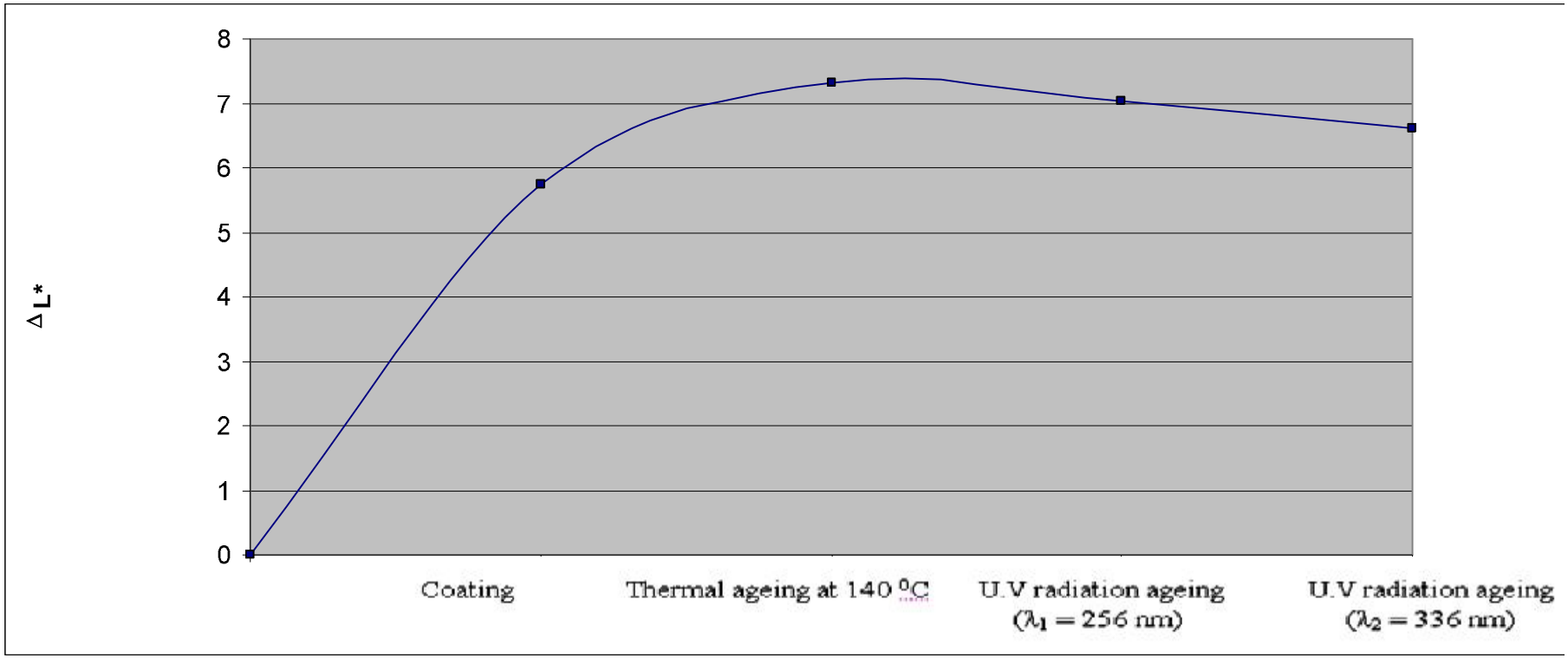

Figure 68: ΔL value of banknote paper (Egyptian 10 pounds "EGP") coated by 2nd L of (0.1%) Carboxymethyl cellulose (CMC) before and after ageing either by thermal ageing at 140 ^{0}C or by UV radiation (λ_1= 256 nm, λ_2 = 336 nm).*

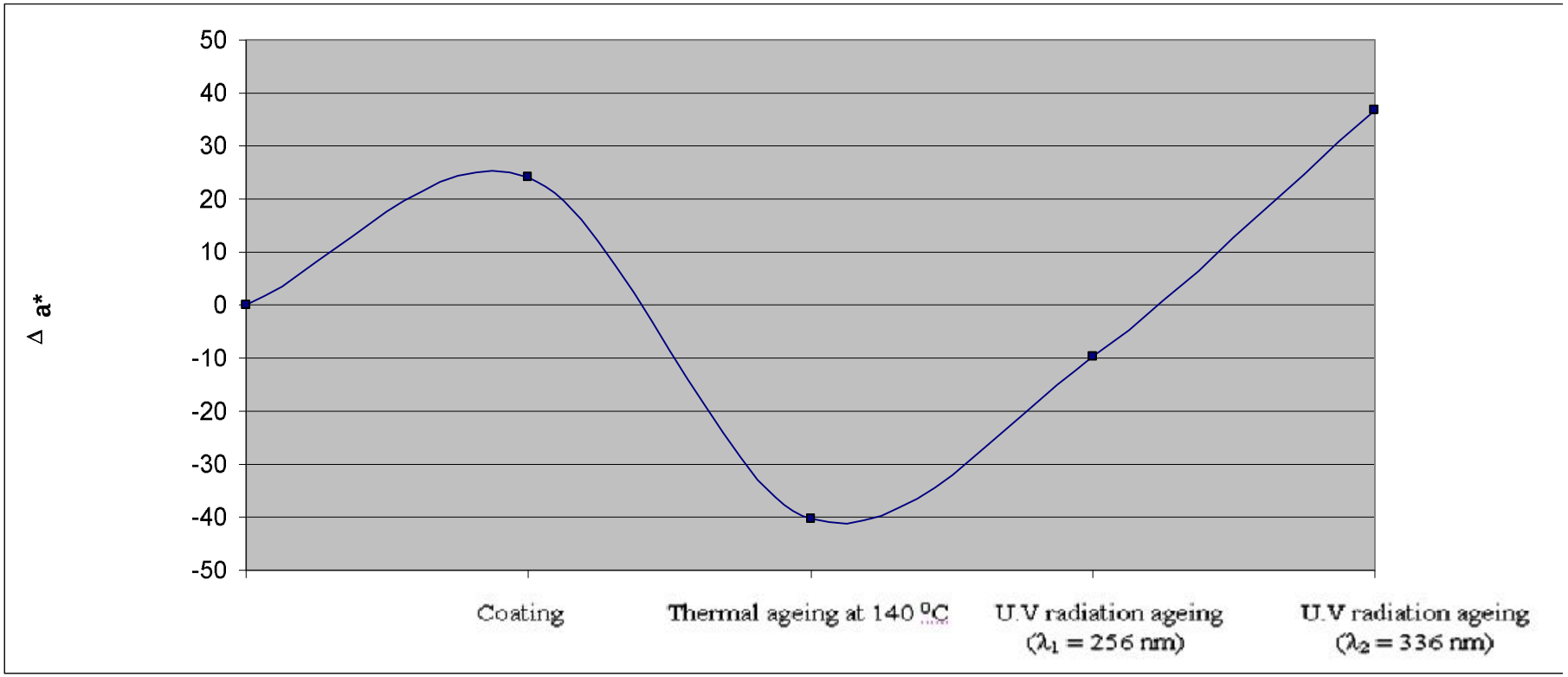

Figure 69: Δa value of banknote paper (Egyptian 10 pounds "EGP") coated by 2nd L of (0.1%) Carboxymethyl cellulose (CMC) before and after ageing either by thermal ageing at 140 ^{0}C or by UV radiation (λ_1= 256 nm, λ_2 = 336 nm).*

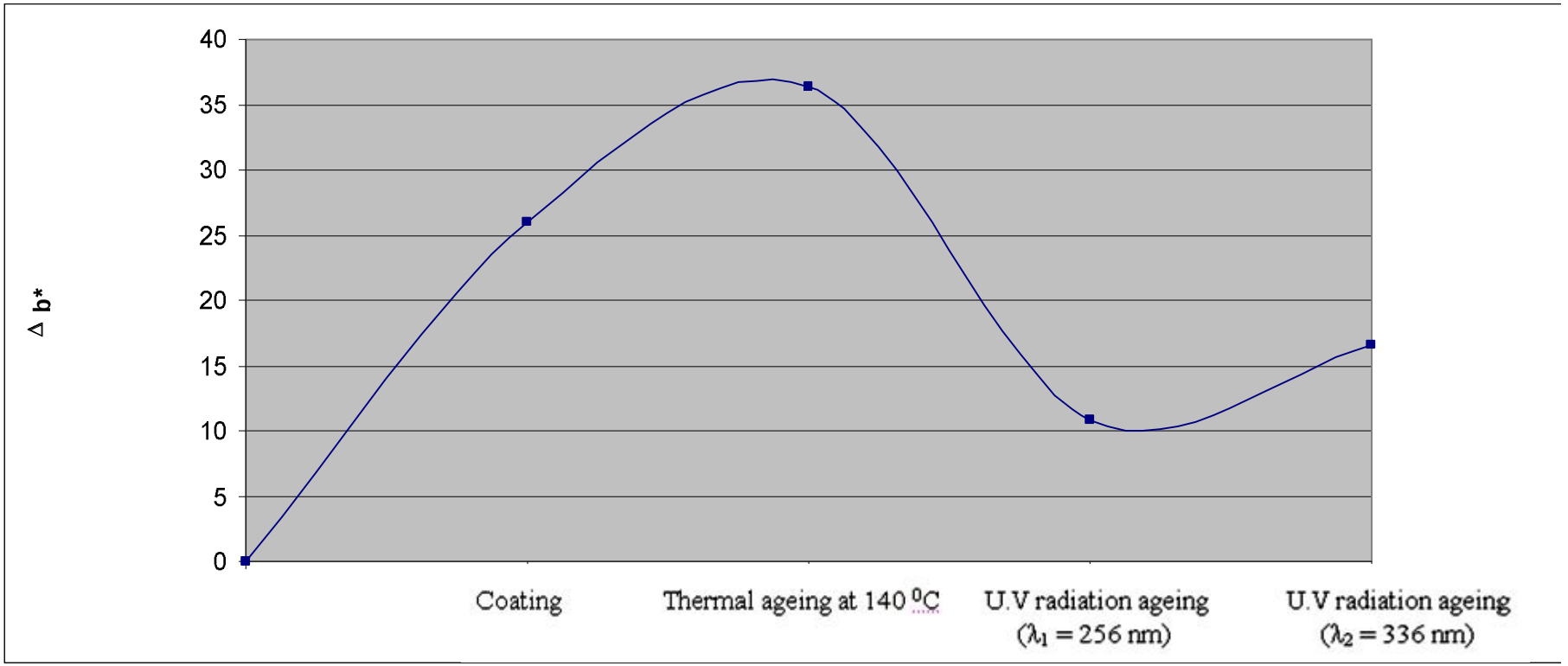

Figure 70: Δb value of banknote paper (Egyptian 10 pounds "EGP") coated by 2nd L of (0.1%) Carboxymethyl cellulose (CMC) before and after ageing either by thermal ageing at 140 ^{0}C or by UV radiation (λ_1= 256 nm, λ_2 = 336 nm).*

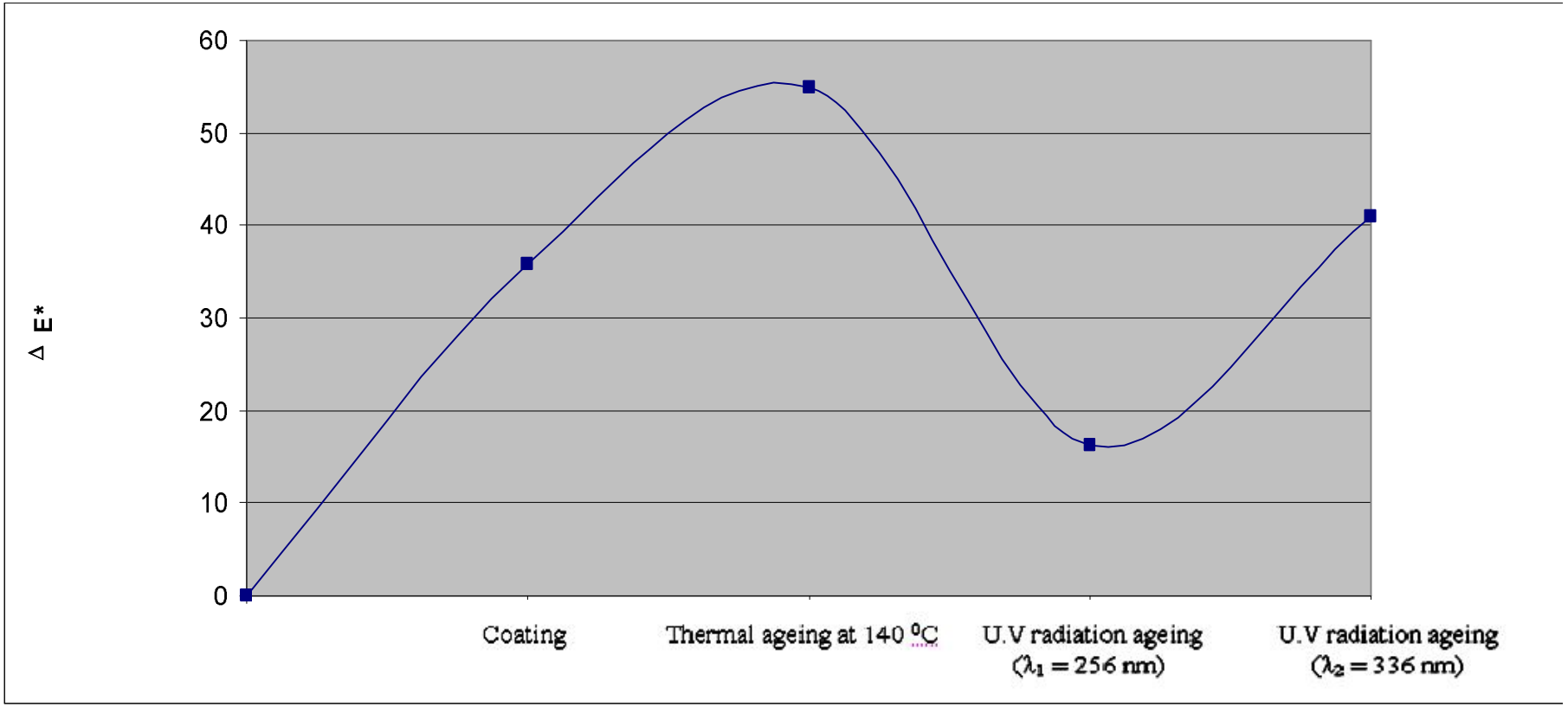

Figure 71: ΔE value of banknote paper (Egyptian 10 pounds "EGP") coated by 2nd L of (0.1%) Carboxymethyl cellulose (CMC) before and after ageing either by thermal ageing at 140 ^{0}C or by UV radiation (λ_1= 256 nm, λ_2 = 336 nm).*

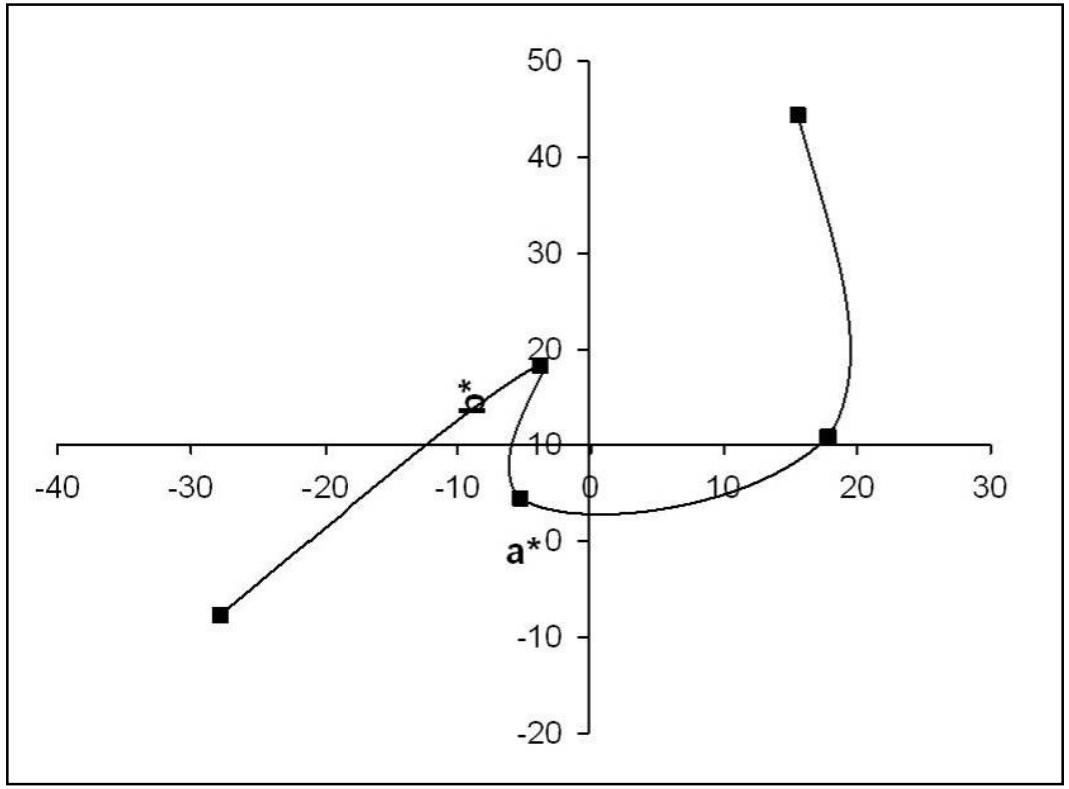

Figure 72: Effect of coating banknote paper (Egyptian 10 pounds "EGP") by 2nd L of (0.1%) Carboxymethyl cellulose (CMC) before and after ageing either by thermal ageing at 140 ^{0}C or by UV radiation (λ_1= 256 nm, λ_2 = 336 nm) on color change.

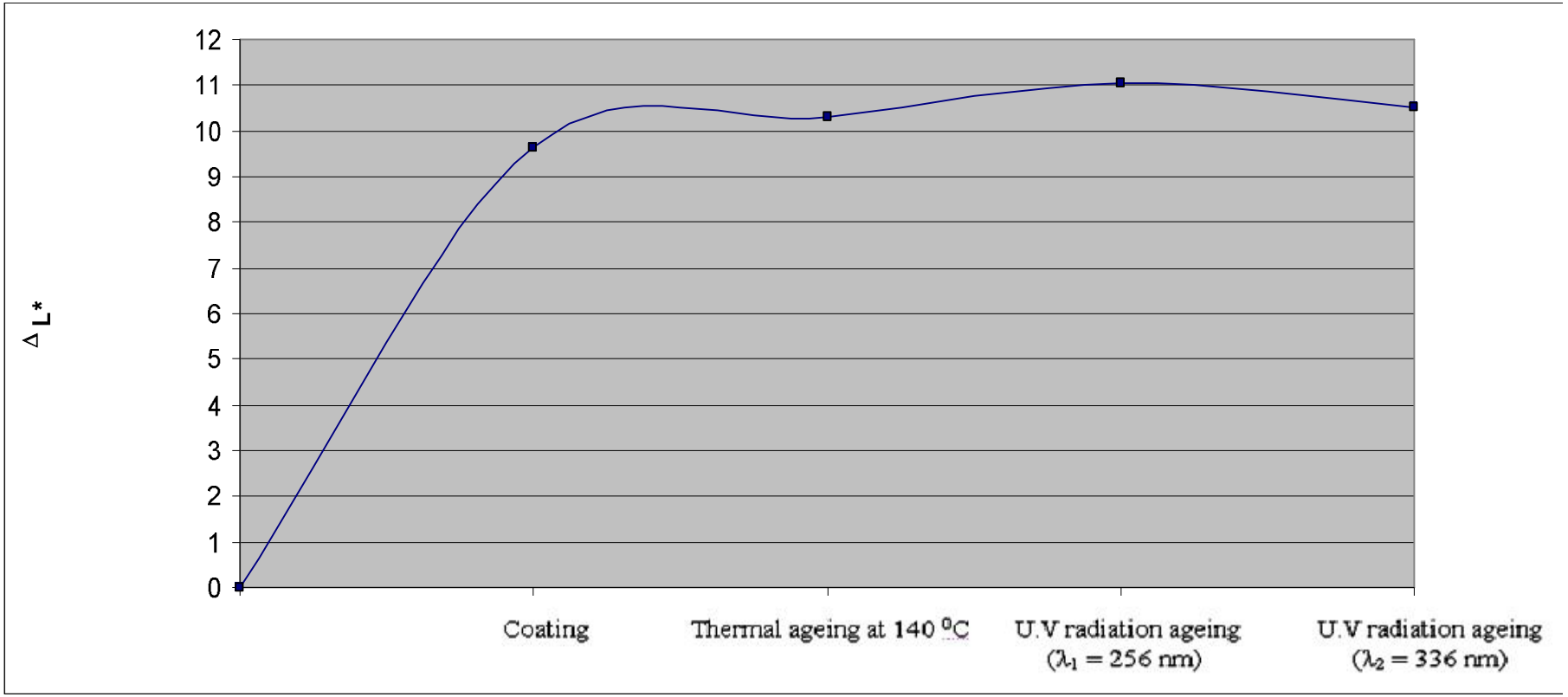

Figure 73: ΔL value of banknote paper (Egyptian 10 pounds "EGP") coated by 2nd L of (1%) Carboxymethyl cellulose (CMC) before and after ageing either by thermal ageing at 140 ^{0}C or by UV radiation (λ_1= 256 nm, λ_2 = 336 nm).*

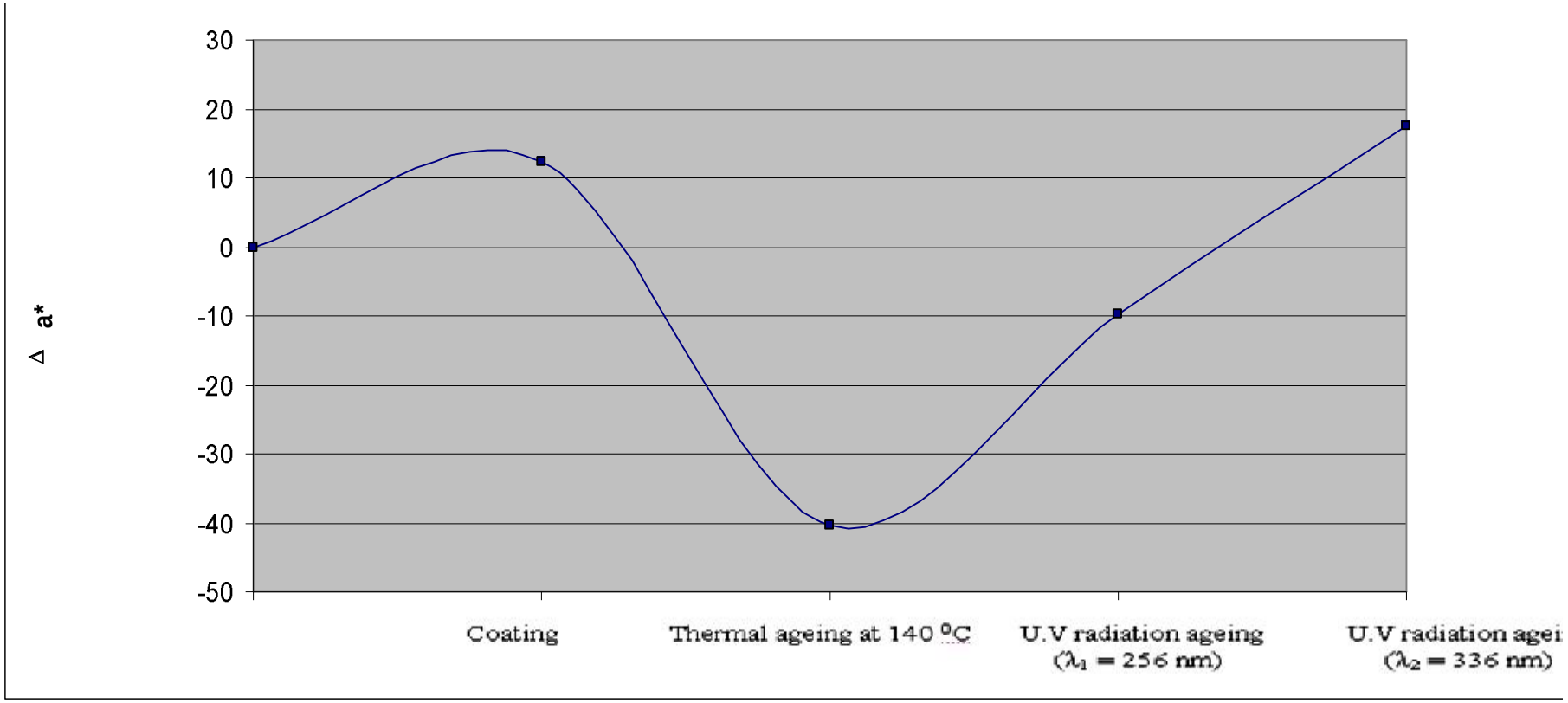

Figure 74: Δa value of banknote paper (Egyptian 10 pounds "EGP") coated by 2nd L of (1%) Carboxymethyl cellulose (CMC) before and after ageing either by thermal ageing at 140 ^{0}C or by UV radiation (λ_1= 256 nm, λ_2 = 336 nm).*

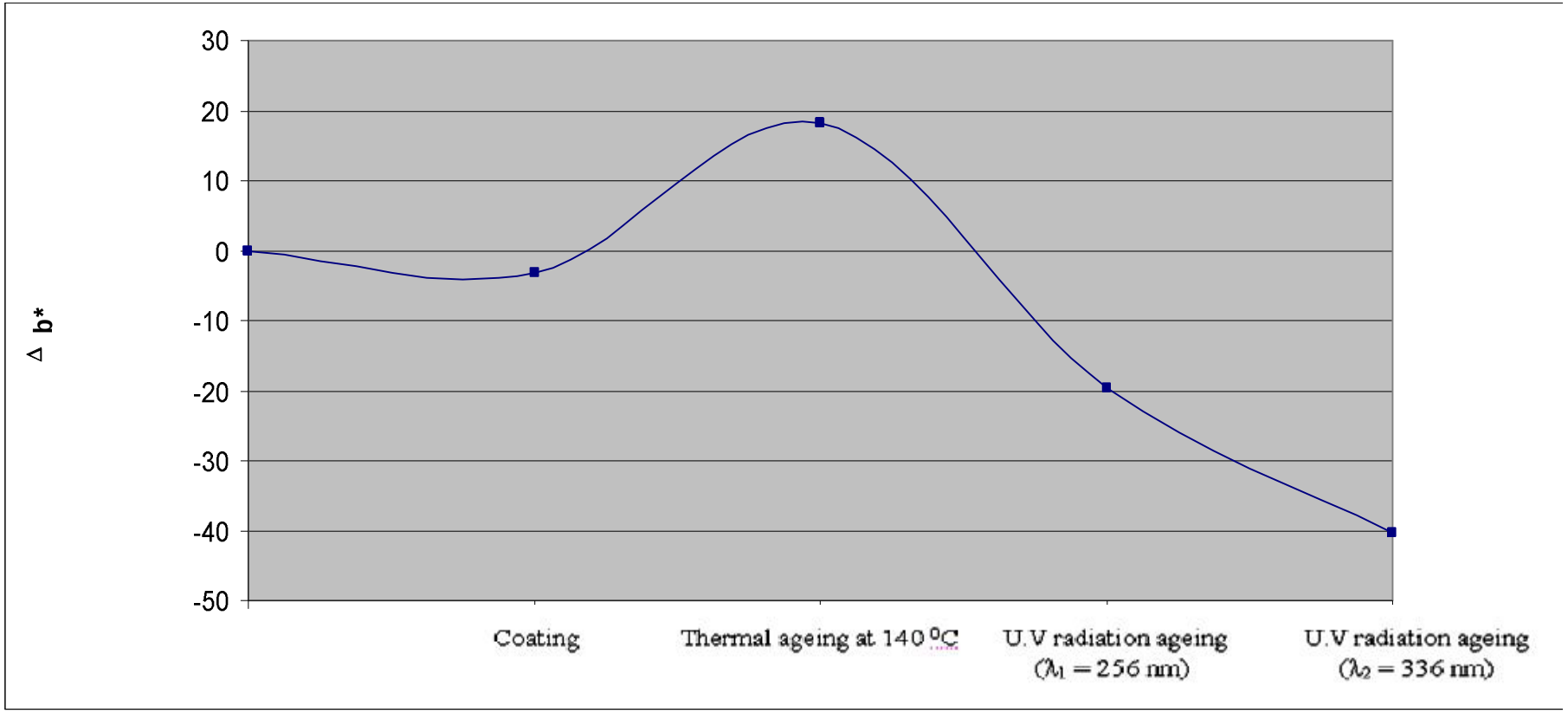

Figure 75: Δb value of banknote paper (Egyptian 10 pounds "EGP") coated by 2nd L of (1%) Carboxymethyl cellulose (CMC) before and after ageing either by thermal ageing at 140 ^{0}C or by UV radiation (λ_1= 256 nm, λ_2 = 336 nm).*

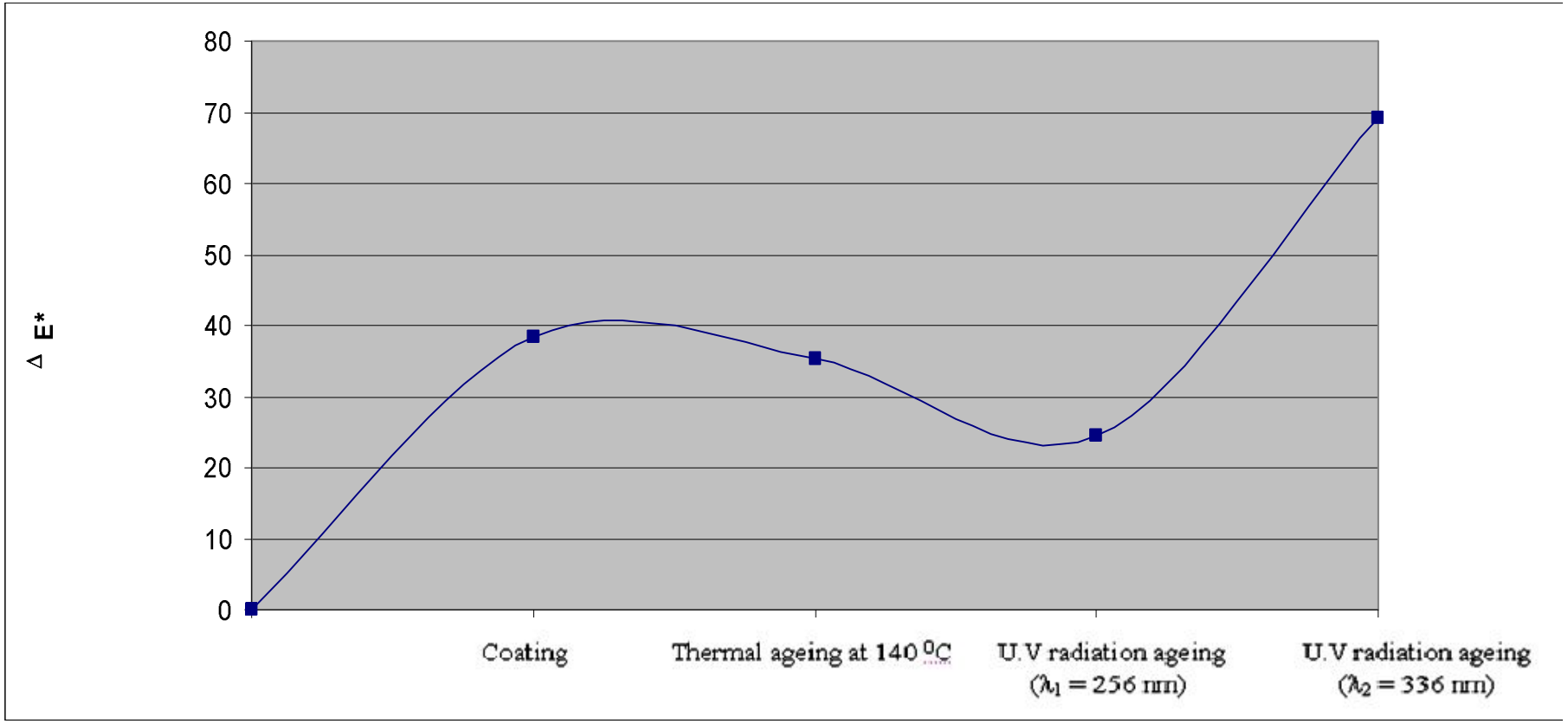

Figure 76: ΔE value of banknote paper (Egyptian 10 pounds "EGP") coated by 2nd L of (1%) Carboxymethyl cellulose (CMC) before and after ageing either by thermal ageing at 140 ^{0}C or by UV radiation (λ_1= 256 nm, λ_2 = 336 nm).*

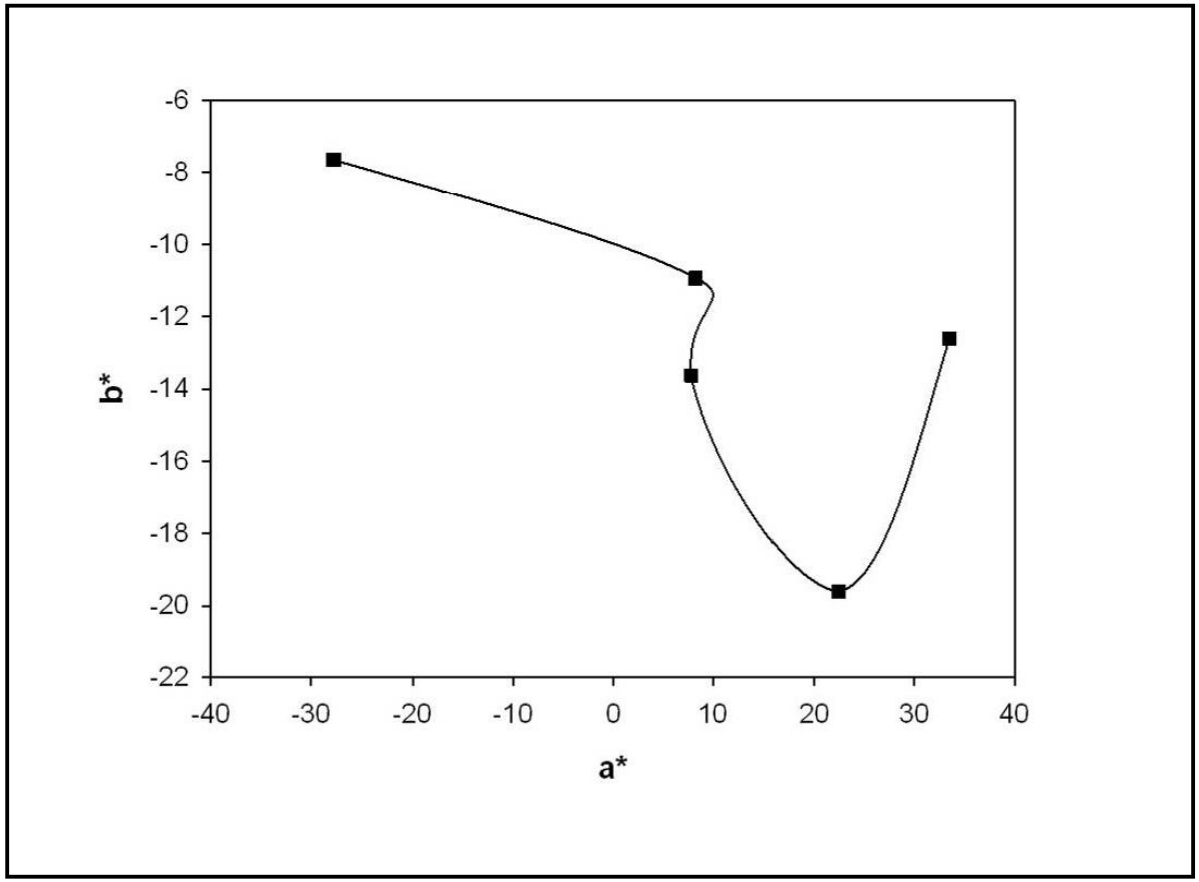

Figure 77: Effect of coating banknote paper (Egyptian 10 pounds "EGP") coated by 2nd L of (1%) Carboxymethyl cellulose (CMC) before and after ageing either by thermal ageing at 140 ^{0}C or by UV radiation (λ_1= 256 nm, λ_2 = 336 nm)on color change.

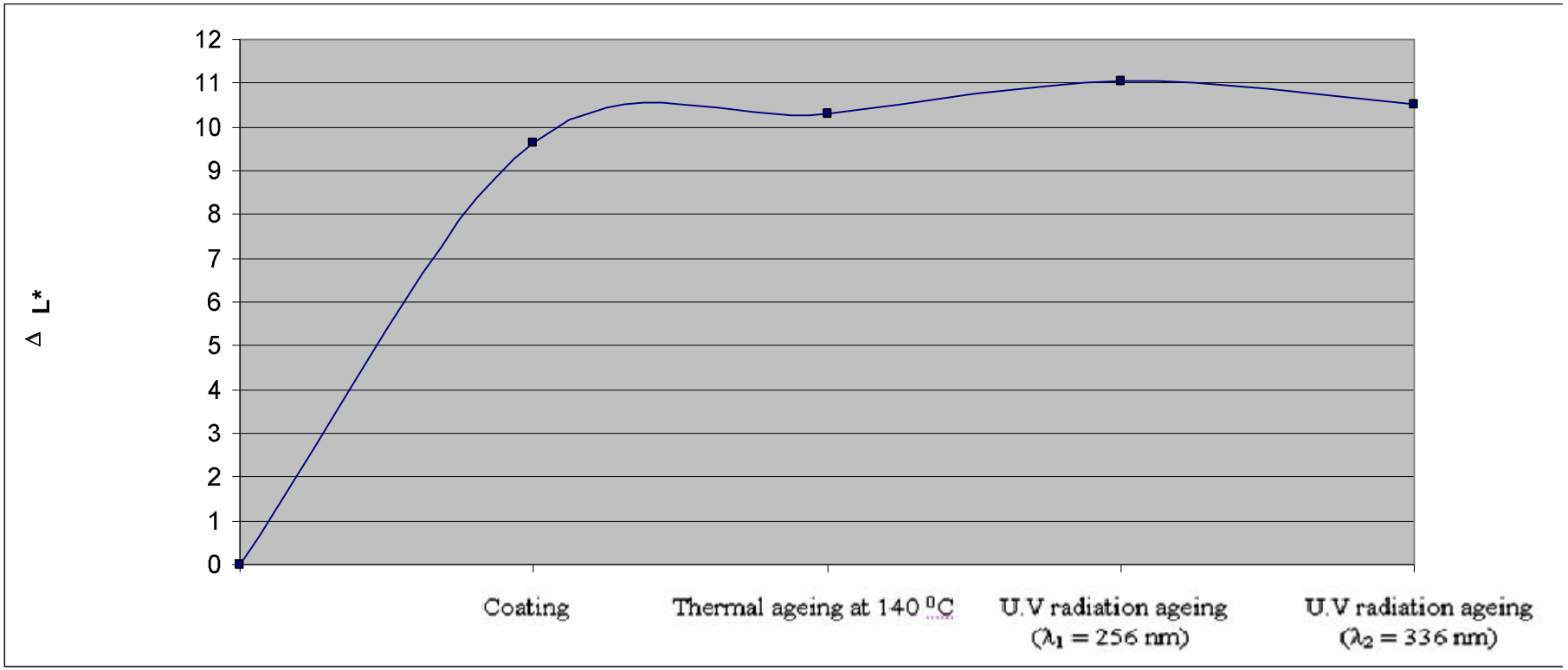

Figure 78: ΔL value of banknote paper (Egyptian 10 pounds "EGP") coated by 3rd L of (0.1%) Carboxymethyl cellulose (CMC) before and after ageing either by thermal ageing at 140 ^{0}C or by UV radiation (λ_1= 256 nm, λ_2 = 336 nm).*

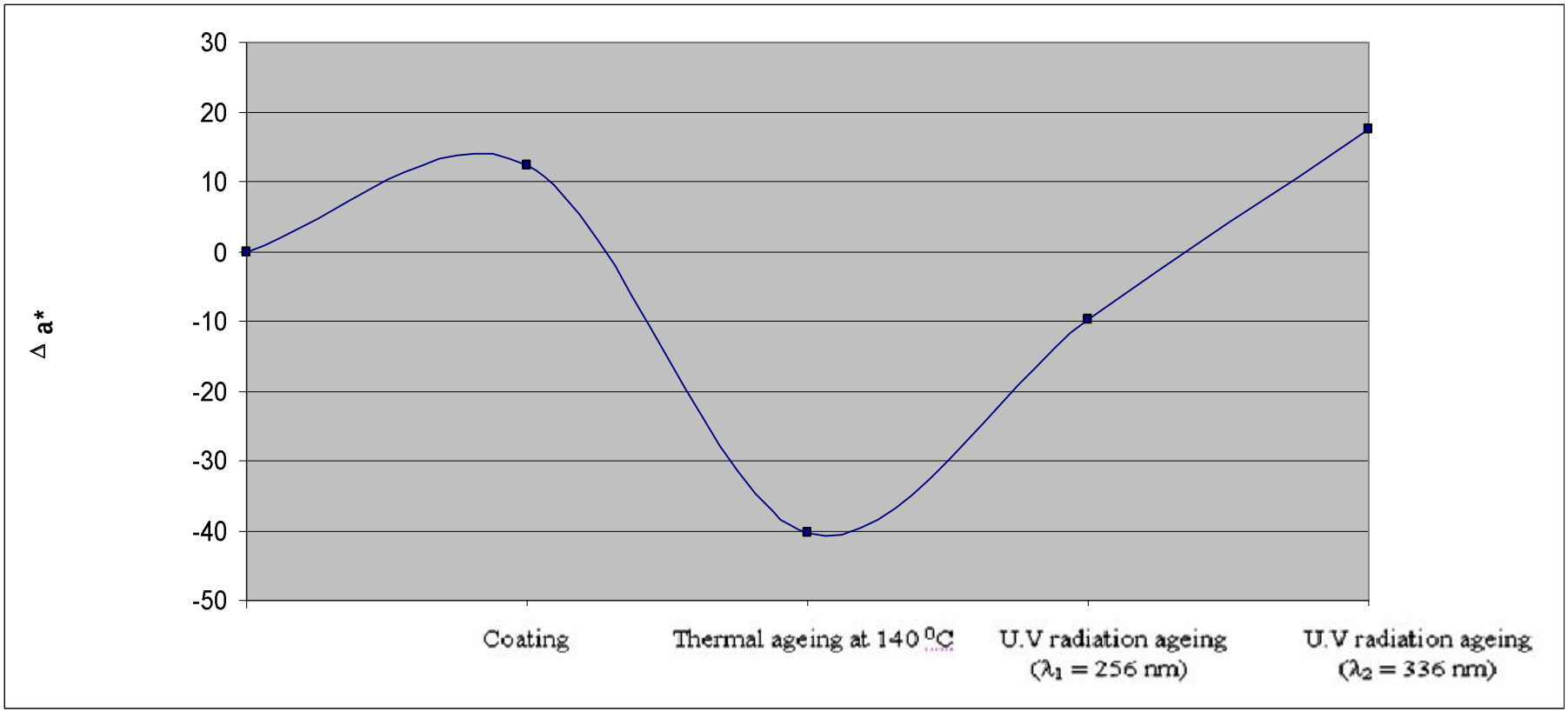

Figure 79: Δa value of banknote paper (Egyptian 10 pounds "EGP") coated by 3rd L of (0.1%) Carboxymethyl cellulose (CMC) before and after ageing either by thermal ageing at 140 ^{0}C or by UV radiation (λ_1= 256 nm, λ_2 = 336 nm).*

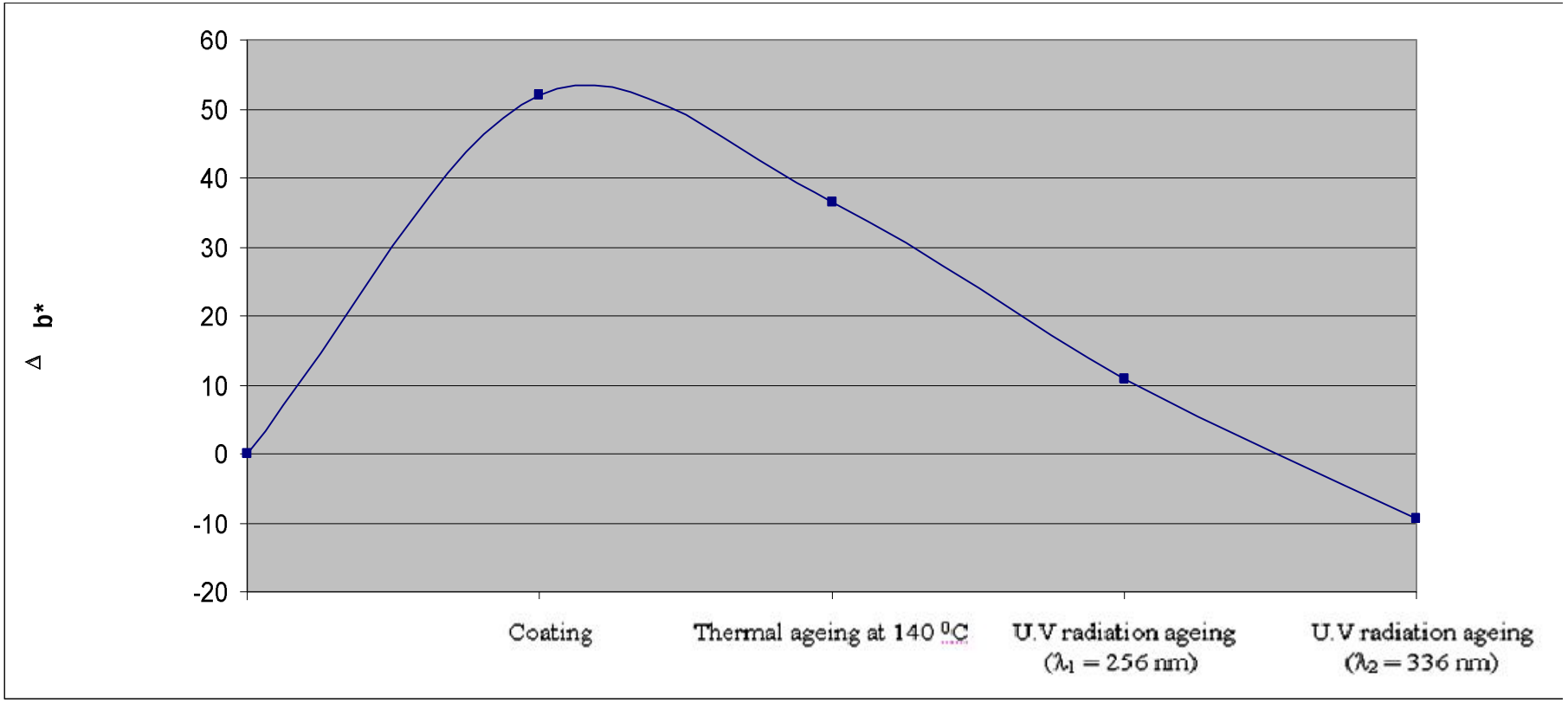

Figure 80: Δb value of banknote paper (Egyptian 10 pounds "EGP") coated by 3rd L of (0.1%) Carboxymethyl cellulose (CMC) before and after ageing either by thermal ageing at 140 ^{0}C or by UV radiation (λ_1= 256 nm, λ_2 = 336 nm).*

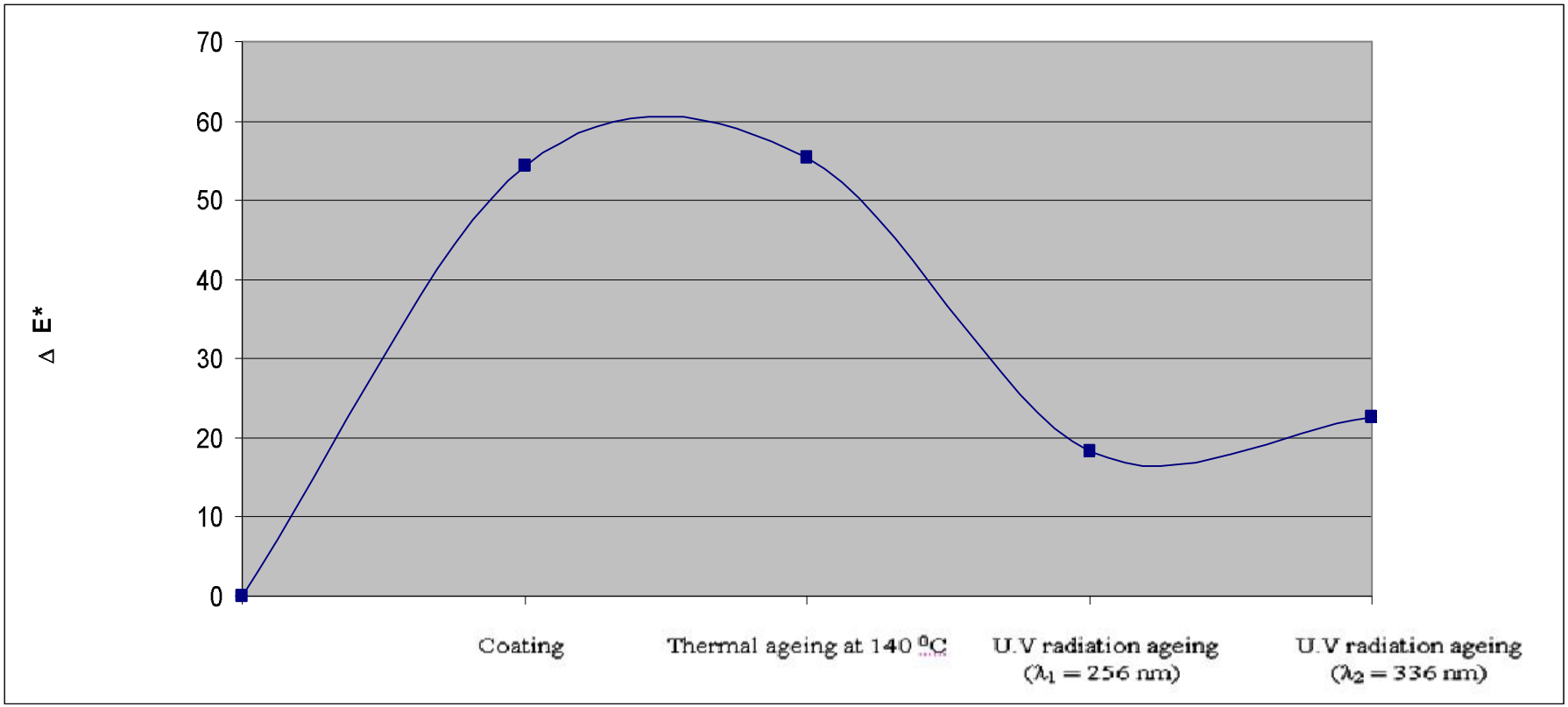

Figure 81: ΔE value of banknote paper (Egyptian 10 pounds "EGP") coated by 3rd L of (0.1%) Carboxymethyl cellulose (CMC) before and after ageing either by thermal ageing at 140 ^{0}C or by UV radiation (λ_1= 256 nm, λ_2 = 336 nm).*

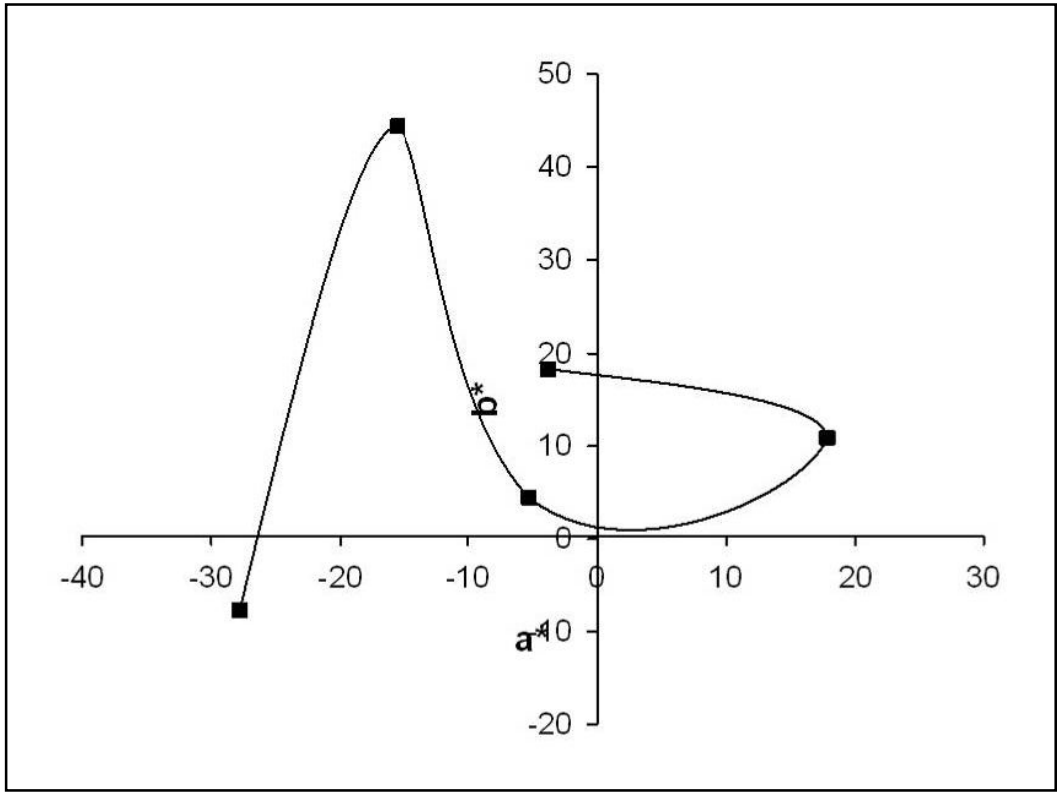

Figure 82: Effect of coating banknote paper (Egyptian 10 pounds "EGP") by 3rd L of (0.1%) Carboxymethyl cellulose (CMC) before and after ageing either by thermal ageing at 140 ^{0}C or by UV radiation (λ_1= 256 nm, λ_2 = 336 nm) on color change.

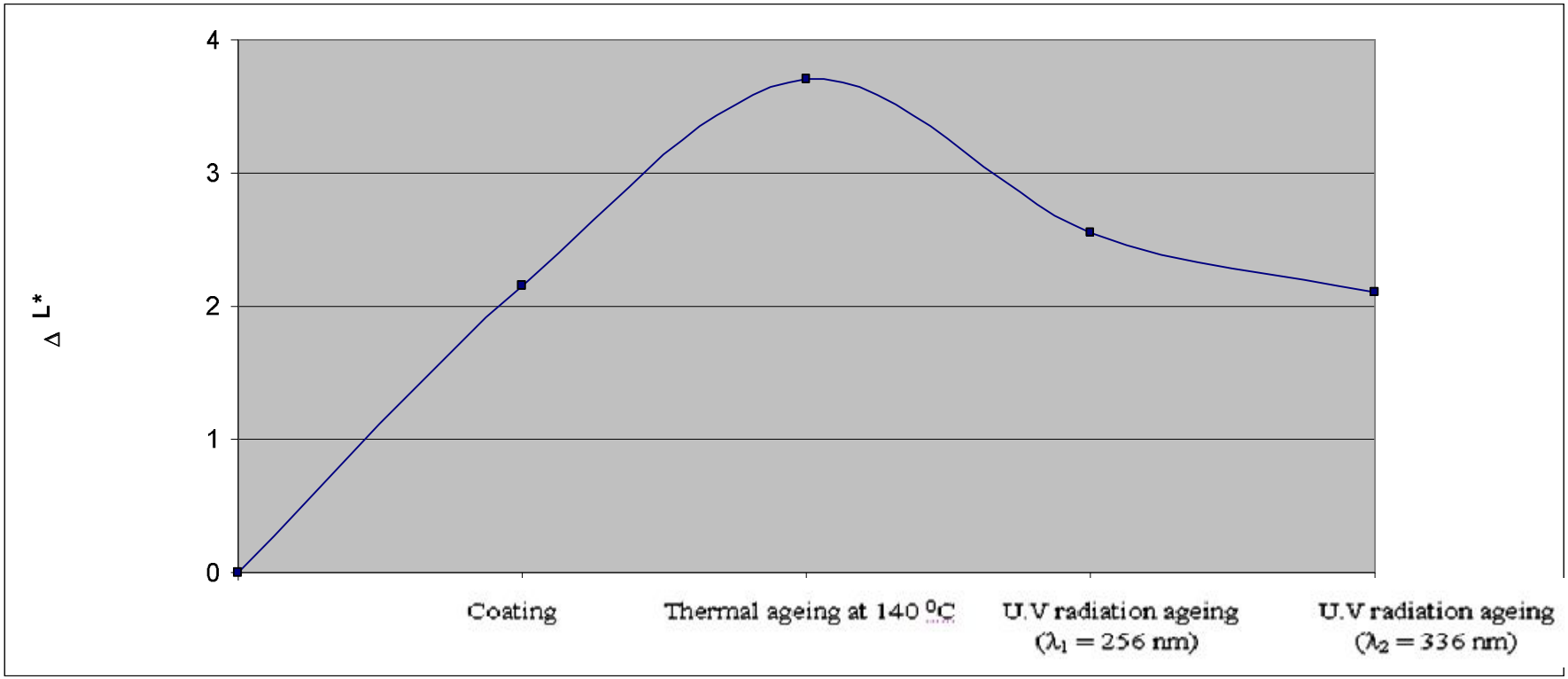

Figure 83: ΔL value of banknote paper (Egyptian 10 pounds "EGP") coated by 3rd L of (1%) Carboxymethyl cellulose (CMC) before and after ageing either by thermal ageing at 140 ^{0}C or by UV radiation (λ_1= 256 nm, λ_2 = 336 nm).*

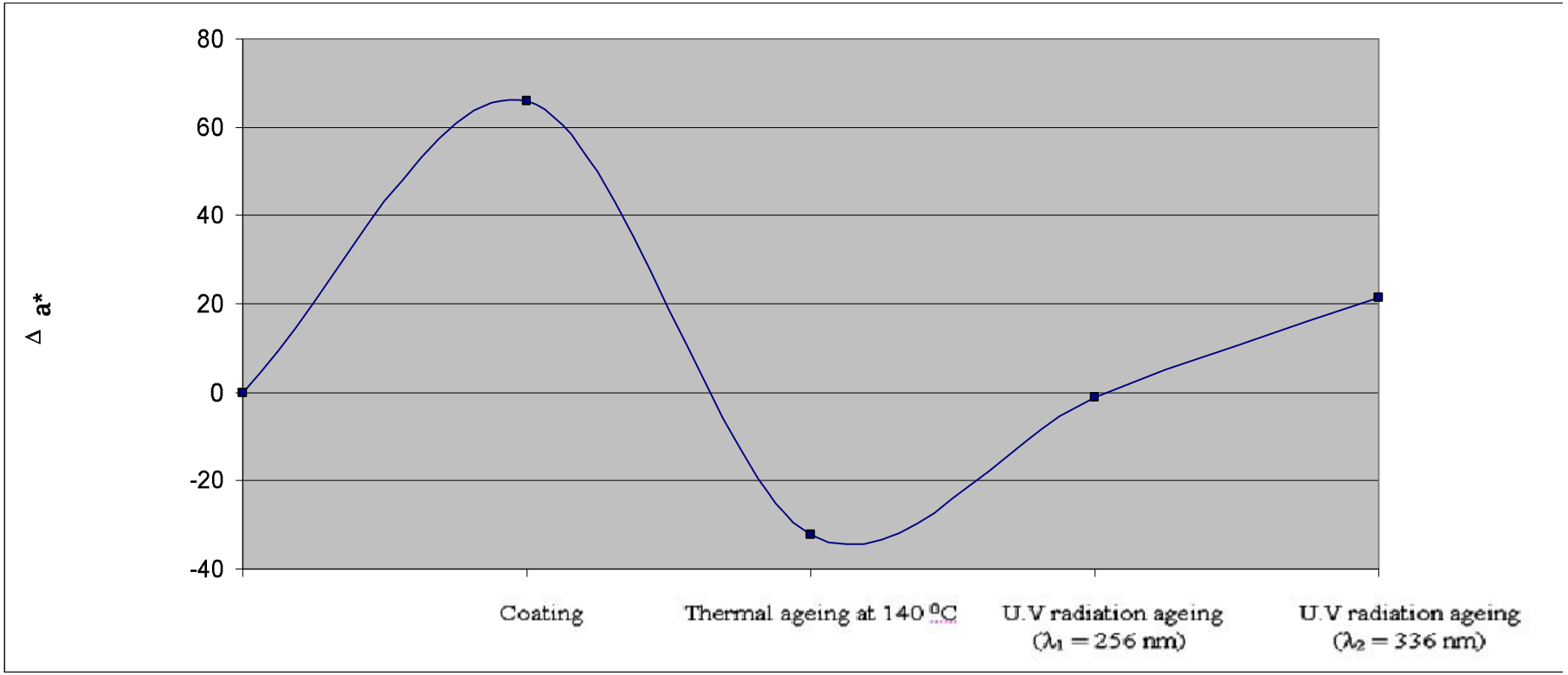

Figure 84: Δa value of banknote paper (Egyptian 10 pounds "EGP") coated by 3rd L of (1%) Carboxymethyl cellulose (CMC) before and after ageing either by thermal ageing at 140 ^{0}C or by UV radiation (λ_1= 256 nm, λ_2 = 336 nm).*

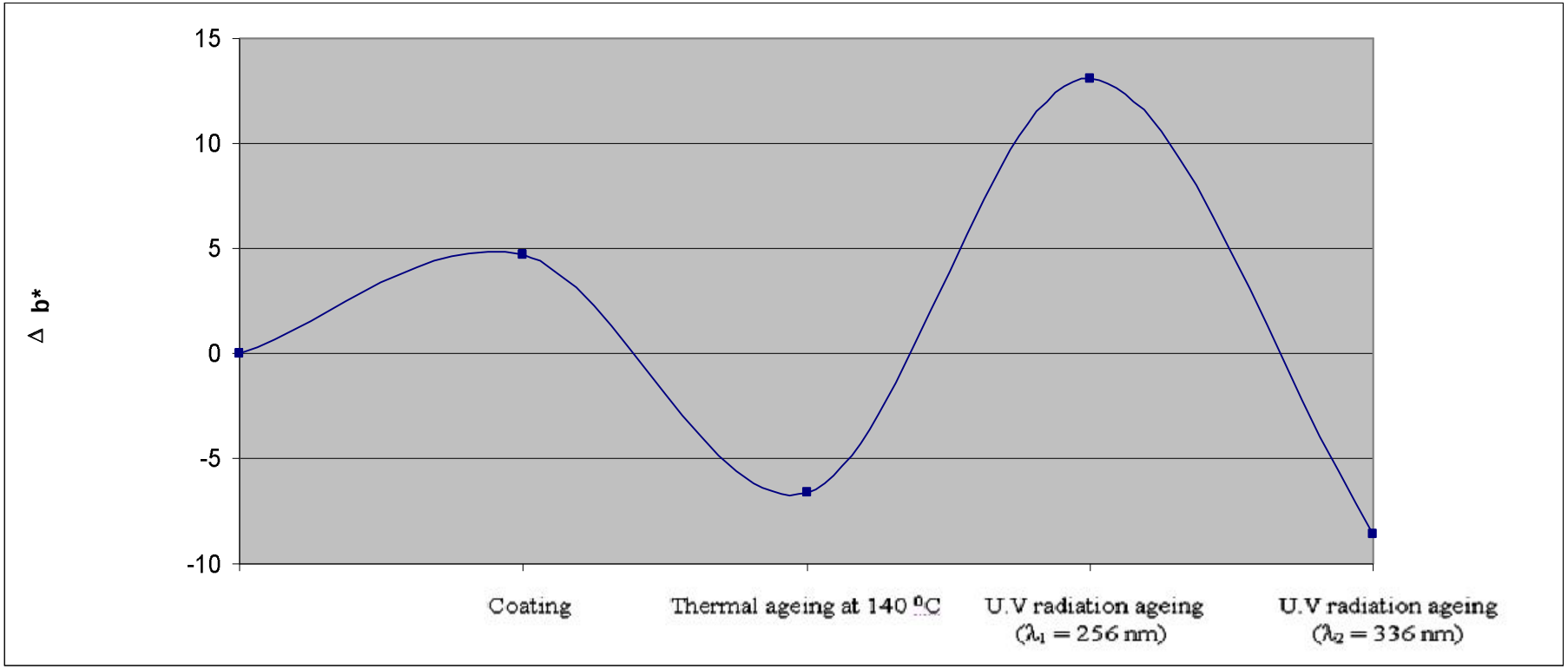

Figure 85: Δb value of banknote paper (Egyptian 10 pounds "EGP") coated by 3rd L of (1%) Carboxymethyl cellulose (CMC) before and after ageing either by thermal ageing at 140 ^{0}C or by UV radiation (λ_1= 256 nm, λ_2 = 336 nm).*

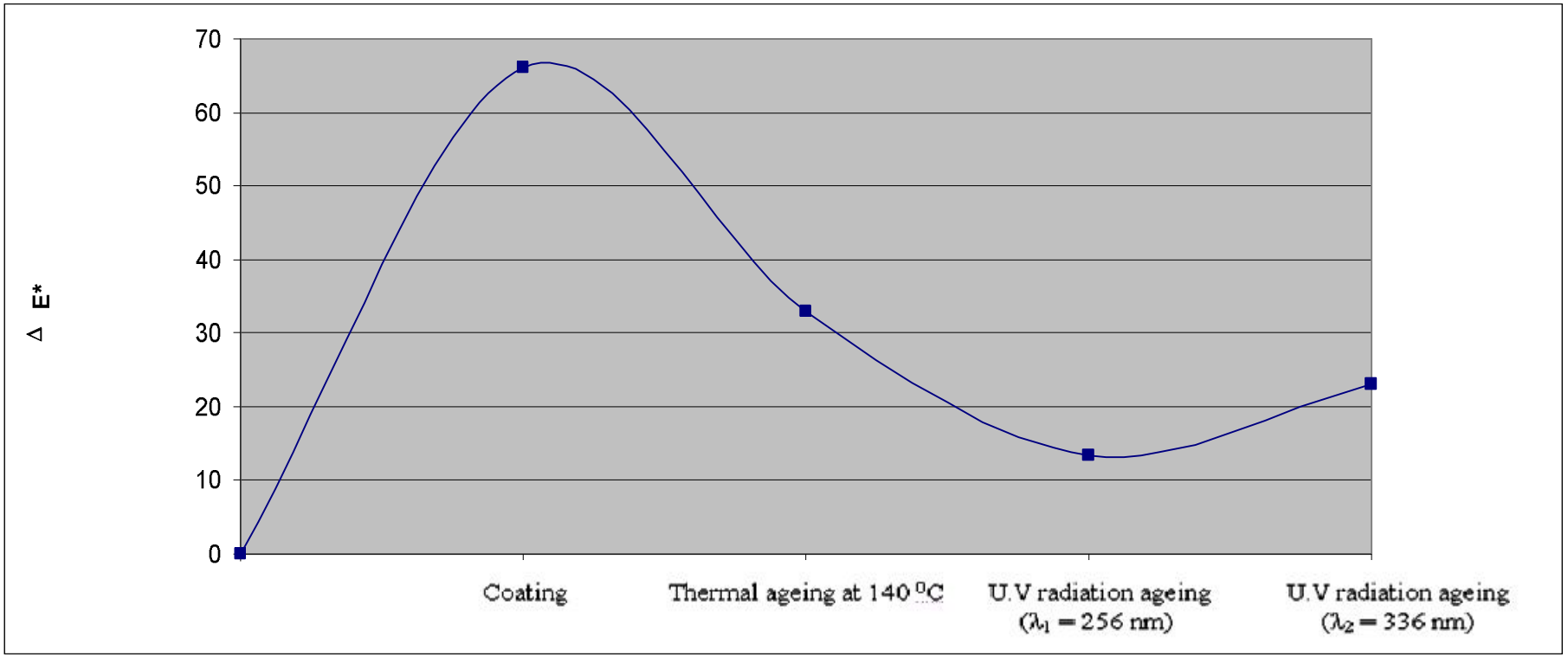

Figure 86: ΔE value of banknote paper (Egyptian 10 pounds "EGP") coated by 3rd L of (1%) Carboxymethyl cellulose (CMC) before and after ageing either by thermal ageing at 140 ^{0}C or by UV radiation (λ_1= 256 nm, λ_2 = 336 nm).*

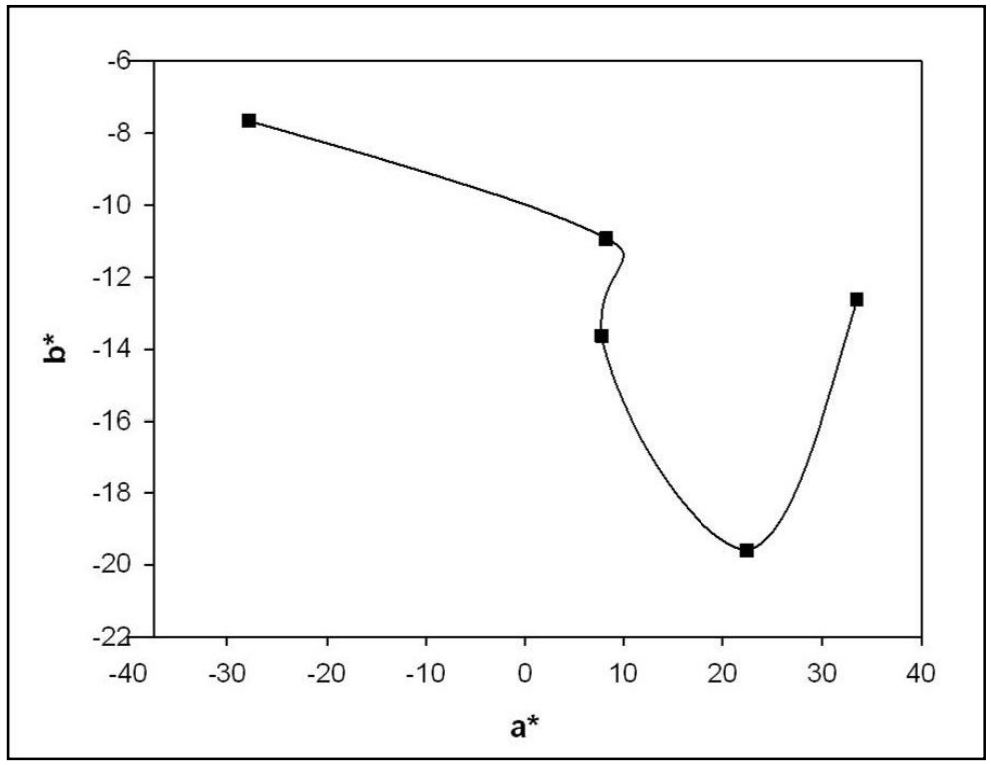

Figure 87: Effect of coating banknote paper (Egyptian 10 pounds "EGP") by 3rd L of (1%) Carboxymethyl cellulose (CMC) before and after ageing either by thermal ageing at 140 ^{0}C or by UV radiation (λ_1= 256 nm, λ_2 = 336 nm) on color change.

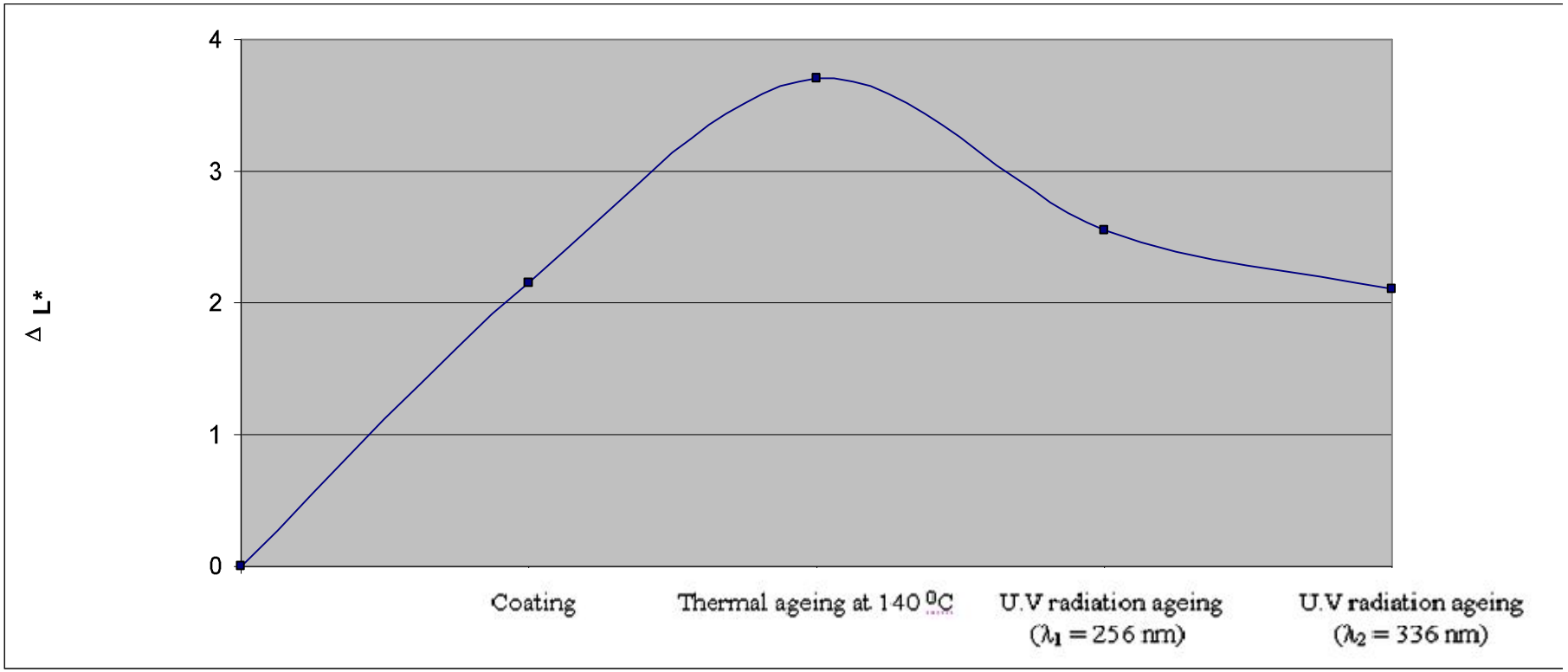

Figure 88: ΔL value of banknote paper (1 Dollar "U$") coated by 1st L of (0.1%) Carboxymethyl cellulose (CMC) before and after ageing either by thermal ageing at 140 ^{0}C or by UV radiation (λ_1= 256 nm, λ_2 = 336 nm).*

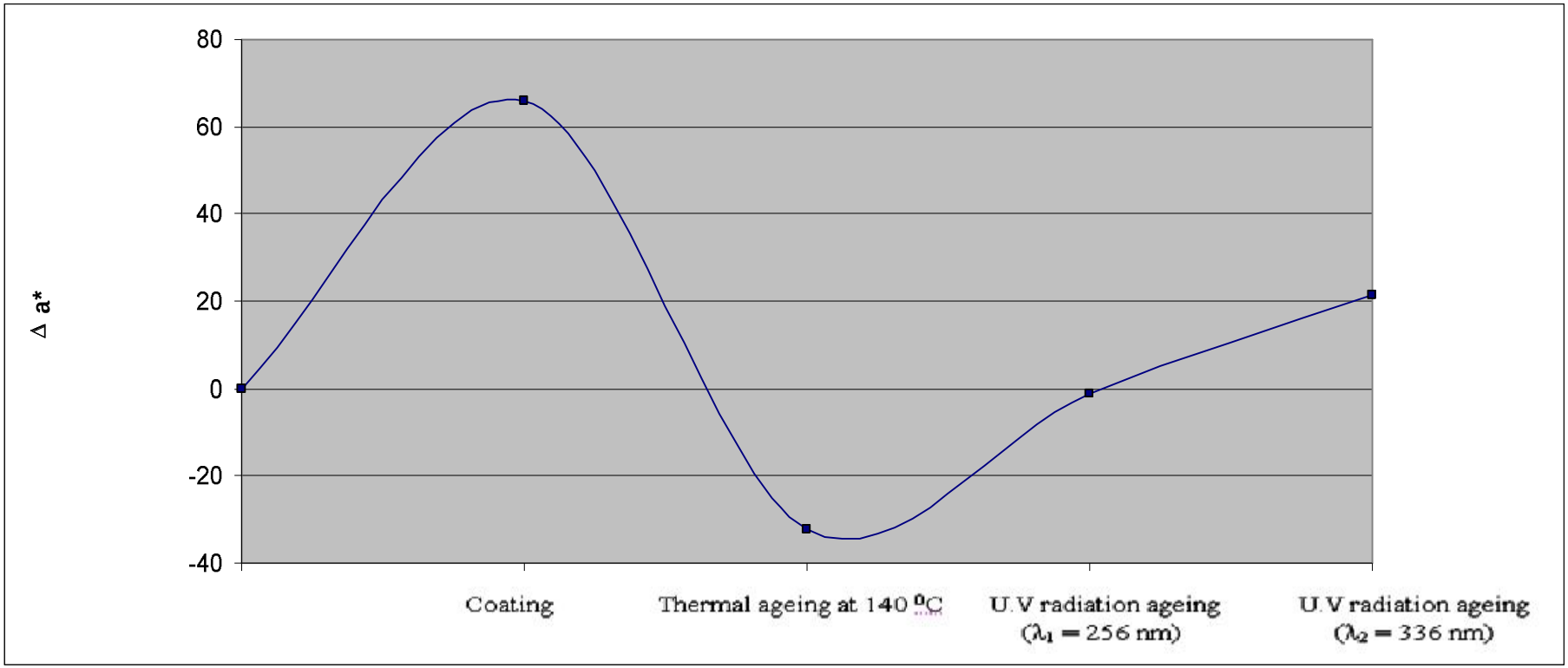

Figure 89: Δa value of banknote paper (1 Dollar "U$") coated by 1st L of (0.1%) Carboxymethyl cellulose (CMC) before and after ageing either by thermal ageing at 140 ^{0}C or by UV radiation (λ_1= 256 nm, λ_2 = 336 nm).*

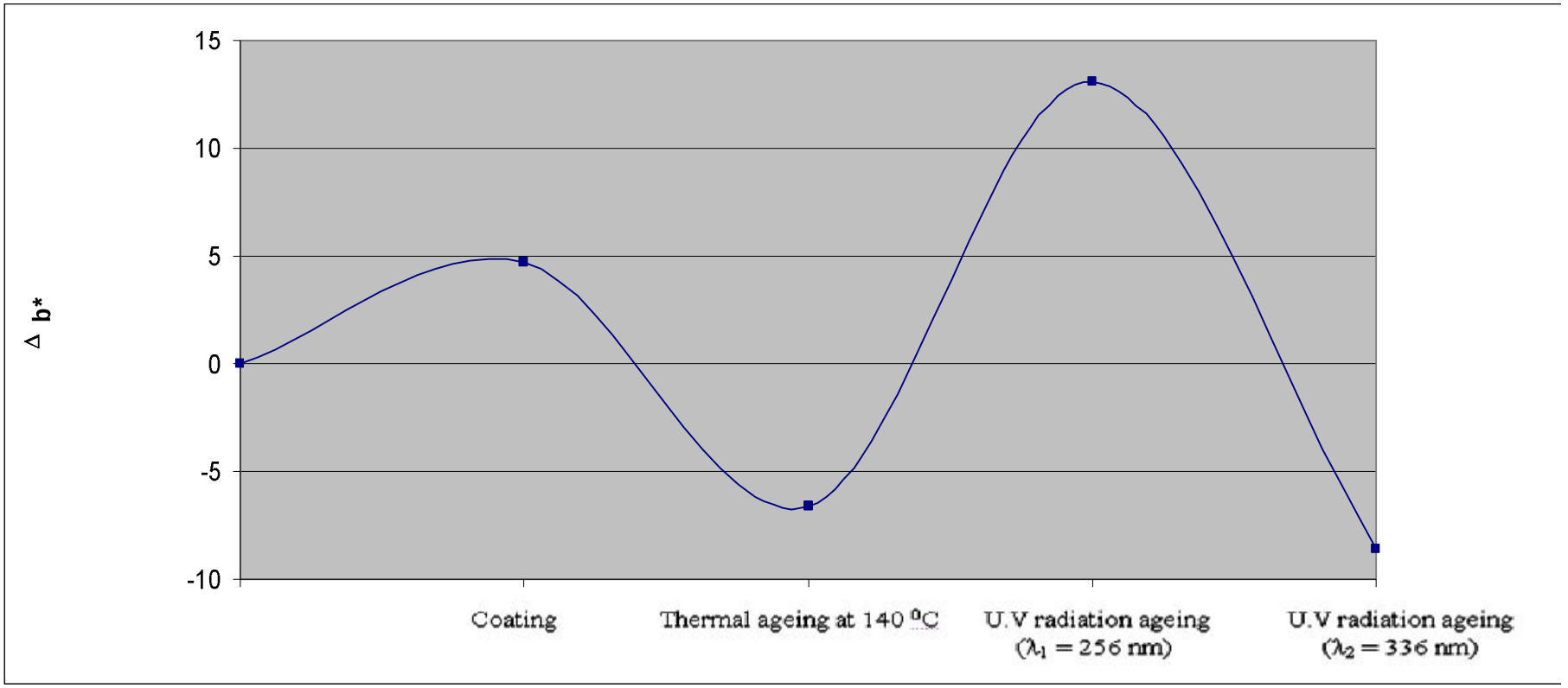

Figure 90: Δb value of banknote paper (1 Dollar "U$") coated by 1st L of (0.1%) Carboxymethyl cellulose (CMC) before and after ageing either by thermal ageing at 140 ^{0}C or by UV radiation (λ_1= 256 nm, λ_2 = 336 nm).*

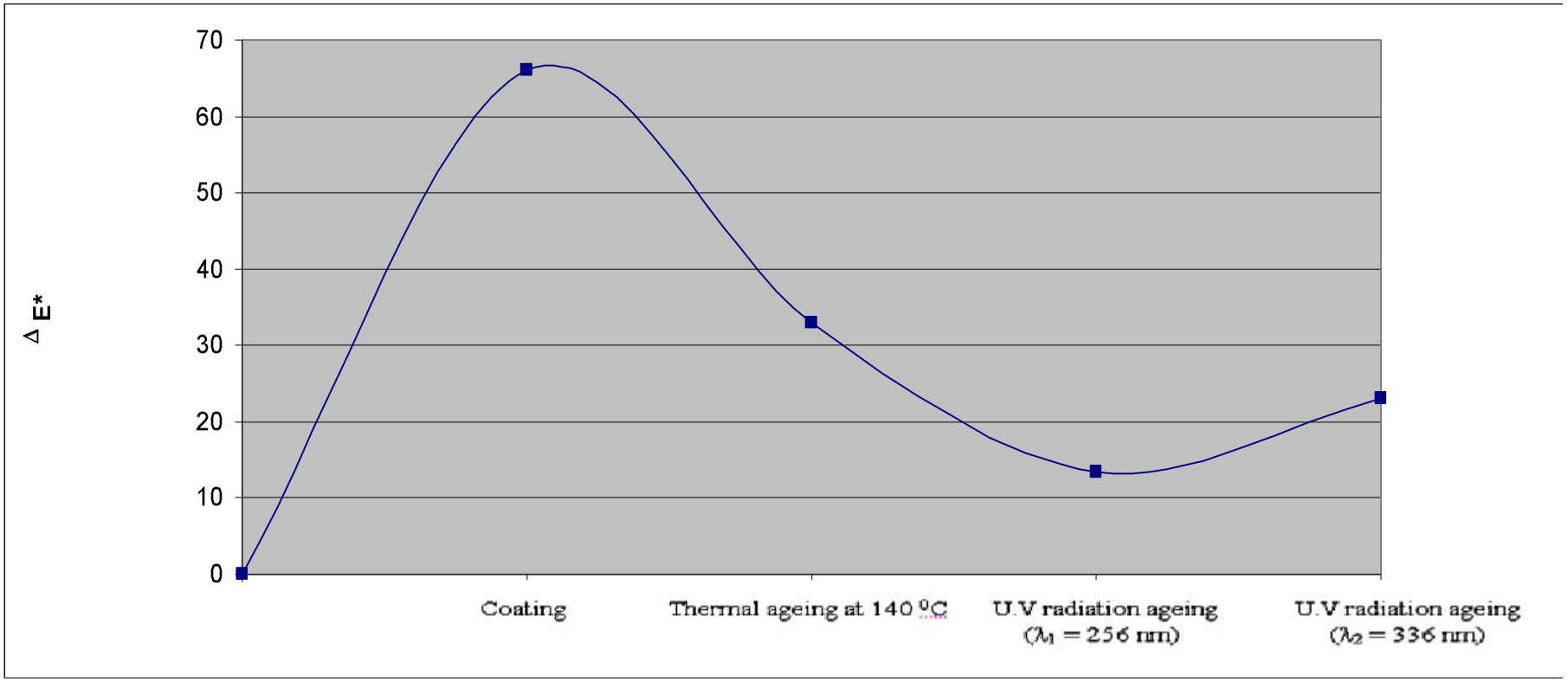

Figure 91: ΔE value of banknote paper (1 Dollar "U$") coated by 1st L of (0.1%) Carboxymethyl cellulose (CMC) before and after ageing either by thermal ageing at 140 ^{0}C or by UV radiation (λ_1= 256 nm, λ_2 = 336 nm).*

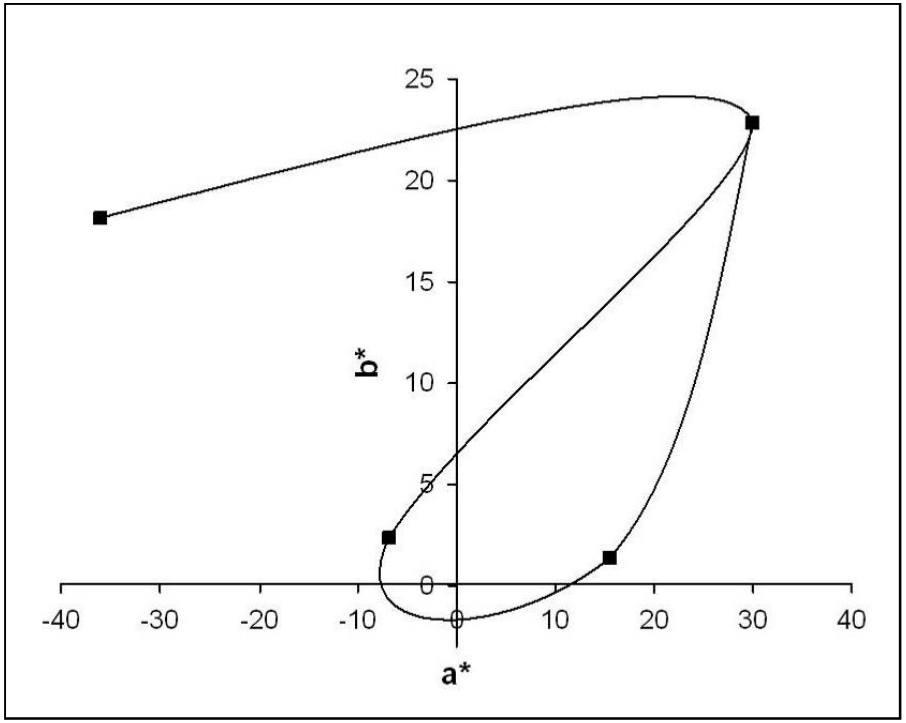

Figure 92: Effect of coating banknote paper (1 Dollar "U$") by 1st L of (0.1%) Carboxymethyl cellulose (CMC) before and after ageing either by thermal ageing at 140 ^{0}C or by UV radiation (λ_1= 256 nm, λ_2 = 336 nm) on color change.

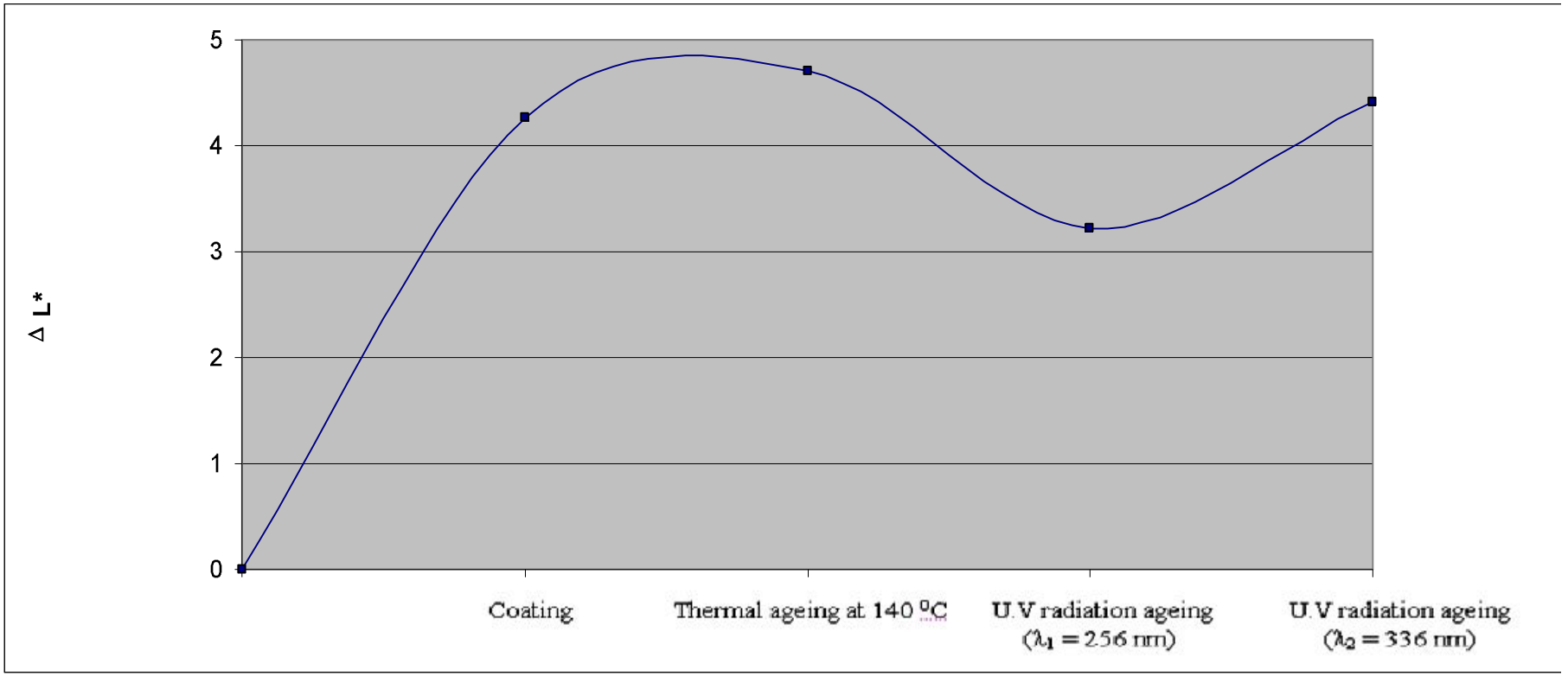

Figure 93: ΔL value of banknote paper (1 Dollar "U$") coated by 1st L of (1%) Carboxymethyl cellulose (CMC) before and after ageing either by thermal ageing at 140 ^{0}C or by UV radiation (λ_1= 256 nm, λ_2 = 336 nm).*

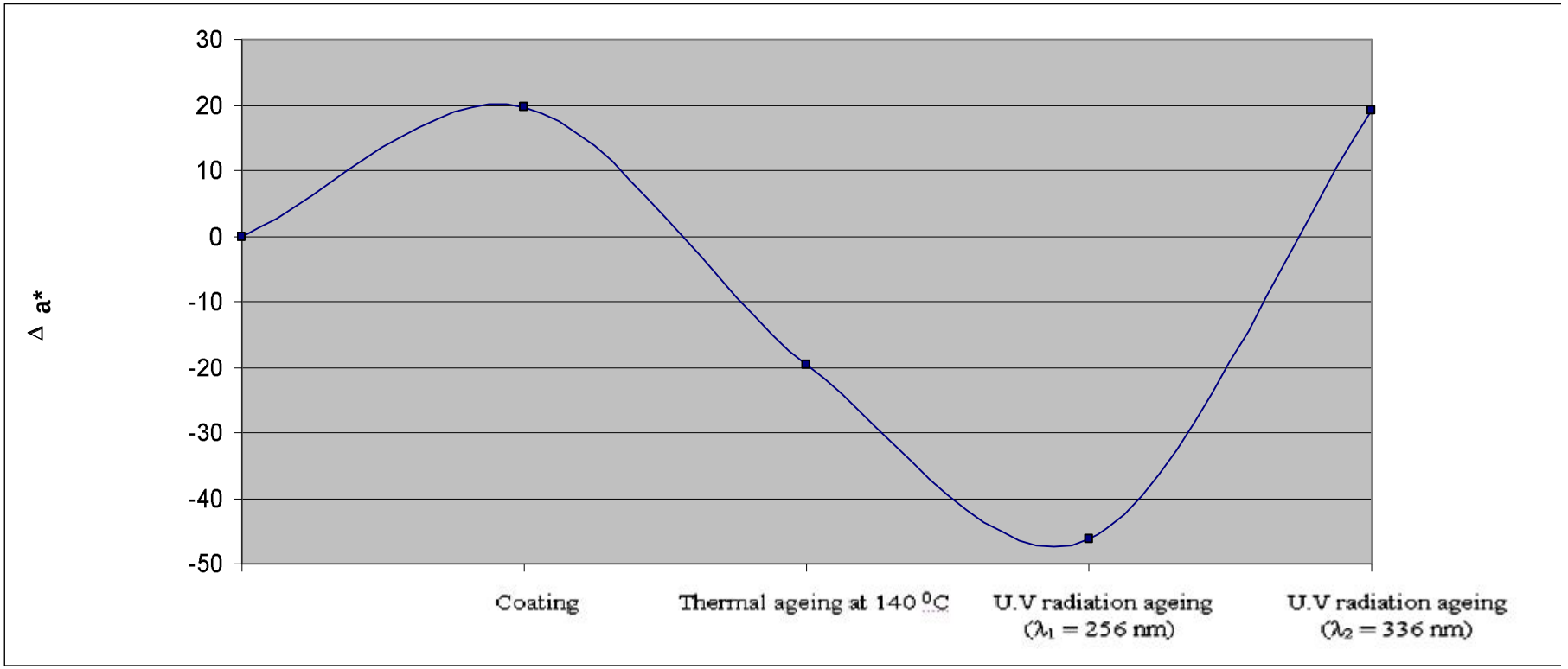

Figure 94: Δa value of banknote paper (1 Dollar "U$") coated by 1st L of (1%) Carboxymethyl cellulose (CMC) before and after ageing either by thermal ageing at 140 ^{0}C or by UV radiation (λ_1= 256 nm, λ_2 = 336 nm).*

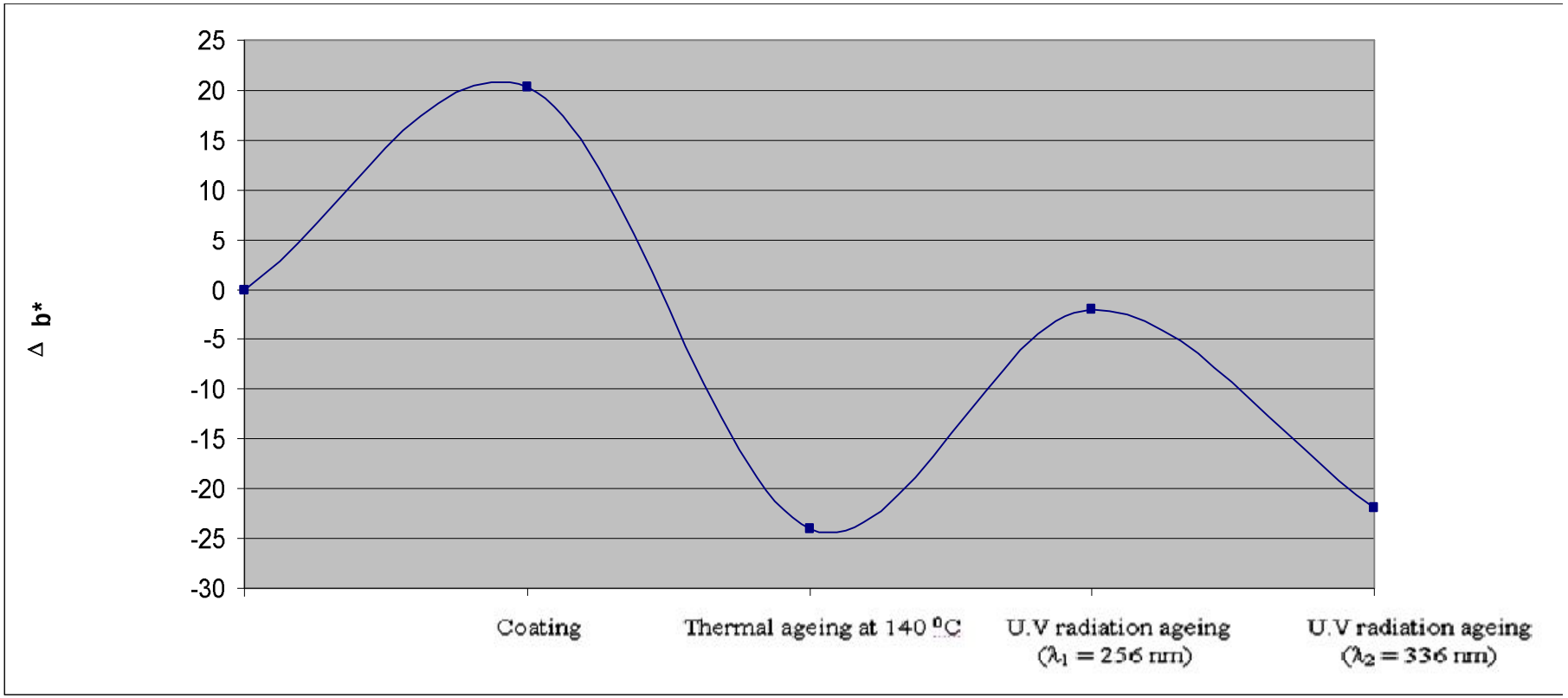

Figure 95: Δb value of banknote paper (1 Dollar "U$") coated by 1st L of (1%) Carboxymethyl cellulose (CMC) before and after ageing either by thermal ageing at 140 ^{0}C or by UV radiation (λ_1= 256 nm, λ_2 = 336 nm).*

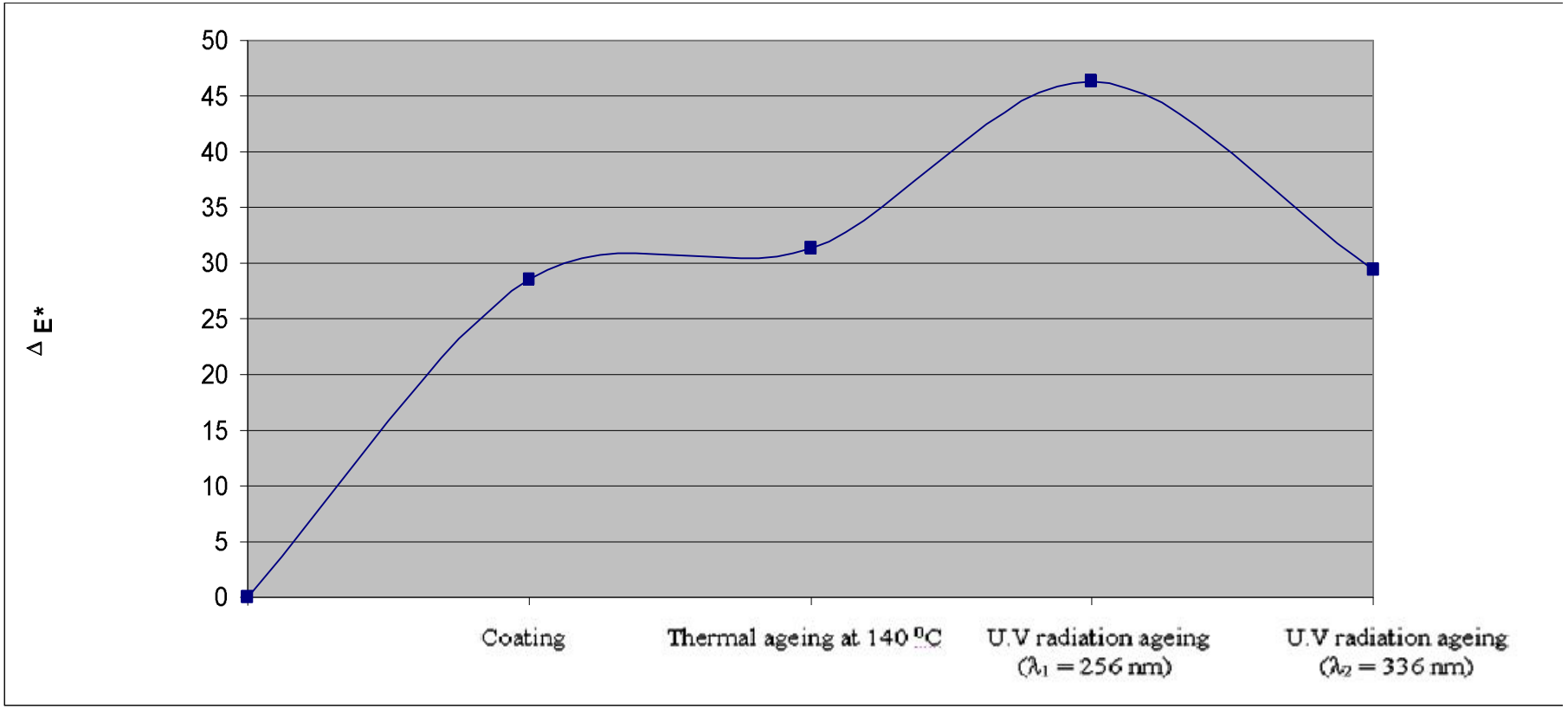

Figure 96: ΔE value of banknote paper (1 Dollar "U$") coated by 1st L of (1%) Carboxymethyl cellulose (CMC) before and after ageing either by thermal ageing at 140 ^{0}C or by UV radiation (λ_1= 256 nm, λ_2 = 336 nm).*

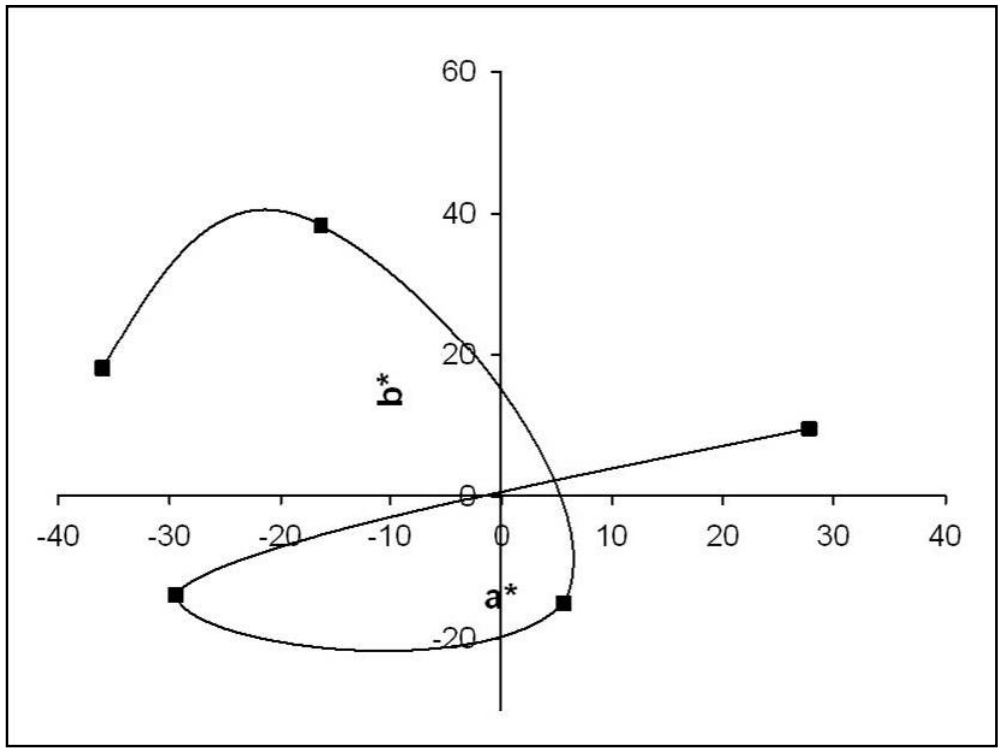

Figure 97: Effect of coating banknote paper (1 Dollar "U$") by 1st L of (1%) Carboxymethyl cellulose (CMC) before and after ageing either by thermal ageing at 140 ^{0}C or by UV radiation (λ_1= 256 nm, λ_2 = 336 nm) on color change.

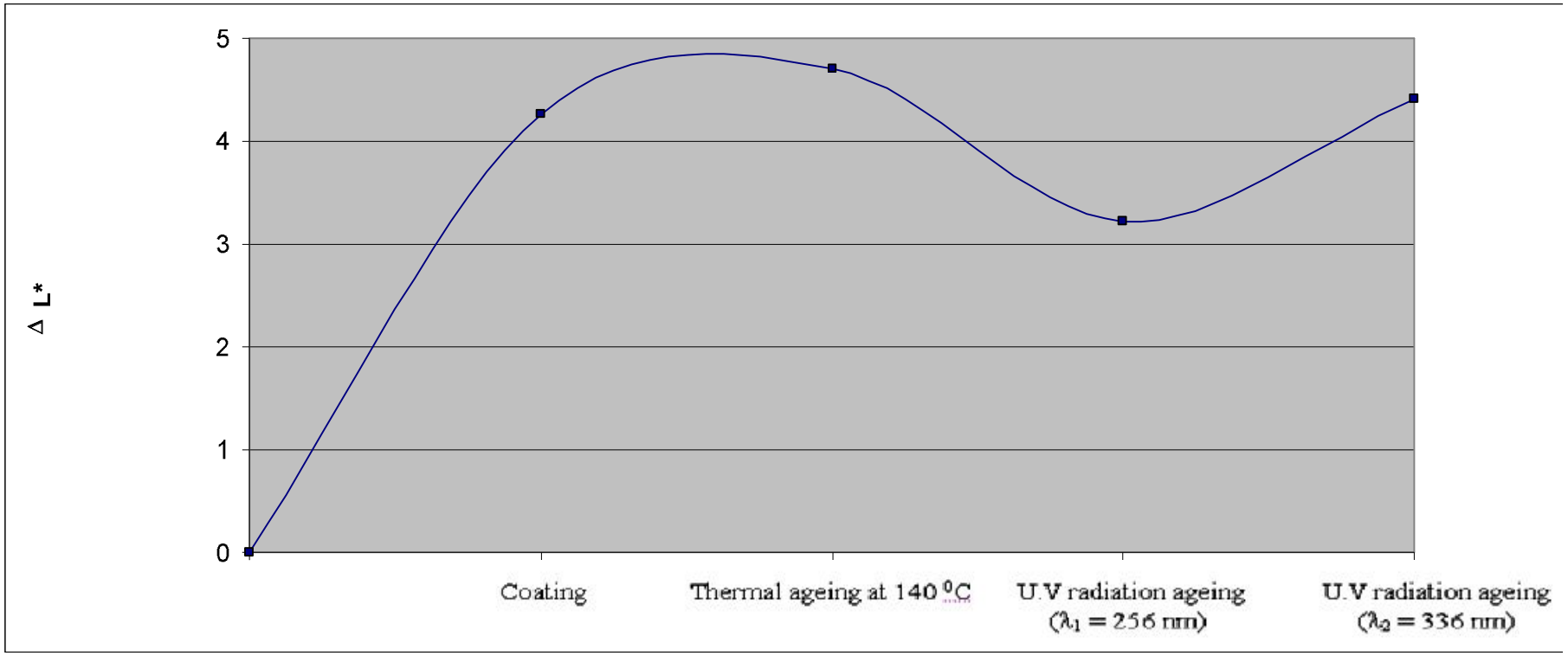

*Figure 98: ΔL*value of banknote paper (1 Dollar "U$") coated by 2nd L of (0.1%) Carboxymethyl cellulose (CMC) before and after ageing either by thermal ageing at 140 ^{0}C or by UV radiation (λ_1= 256 nm, λ_2 = 336 nm).*

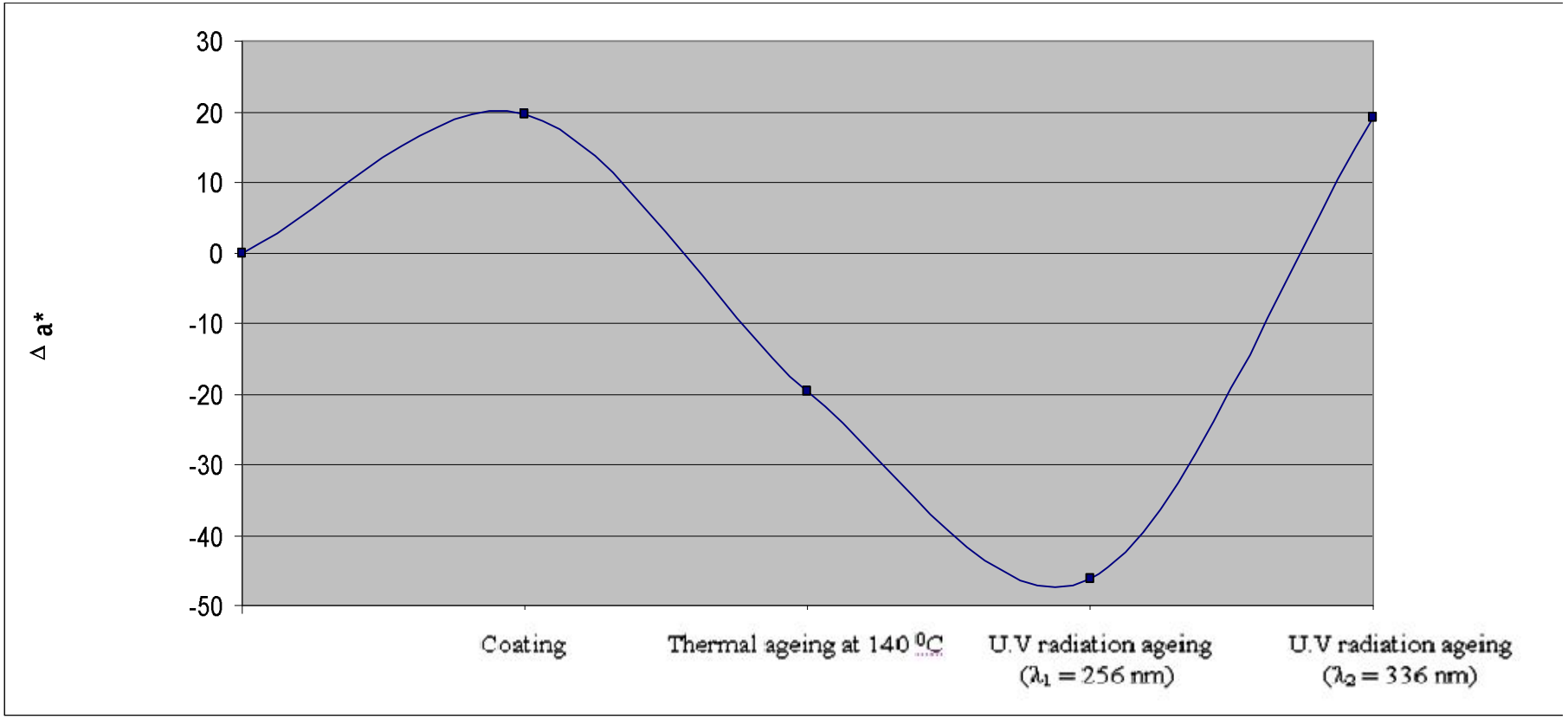

Figure 99: Δa value of banknote paper (1 Dollar "U$") coated by 2nd L of (0.1%) Carboxymethyl cellulose (CMC) before and after ageing either by thermal ageing at 140 ^{0}C or by UV radiation (λ_1= 256 nm, λ_2 = 336 nm).*

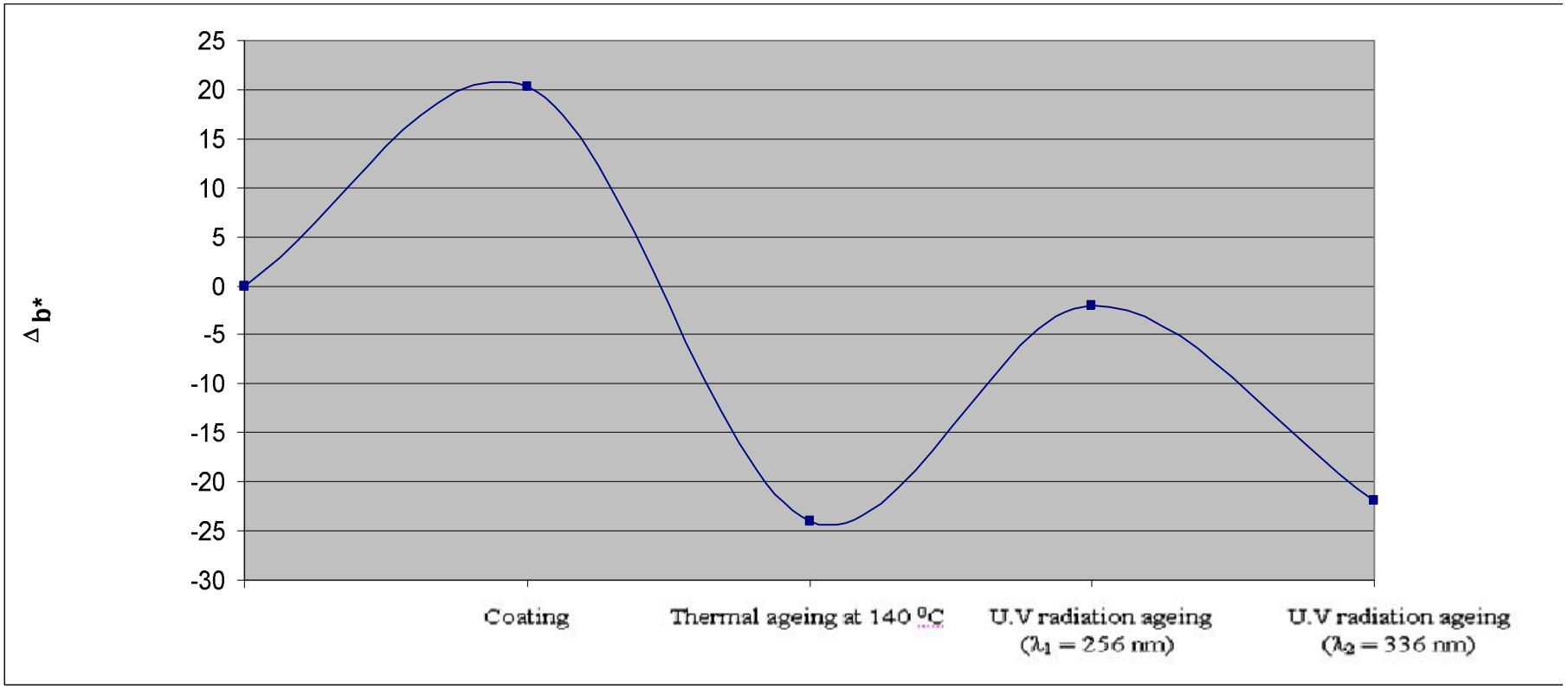

Figure 100: Δb value of banknote paper (1 Dollar "U$") coated by 2nd L of (0.1%) Carboxymethyl cellulose (CMC) before and after ageing either by thermal ageing at 140 ^{0}C or by UV radiation (λ_1= 256 nm, λ_2 = 336 nm).*

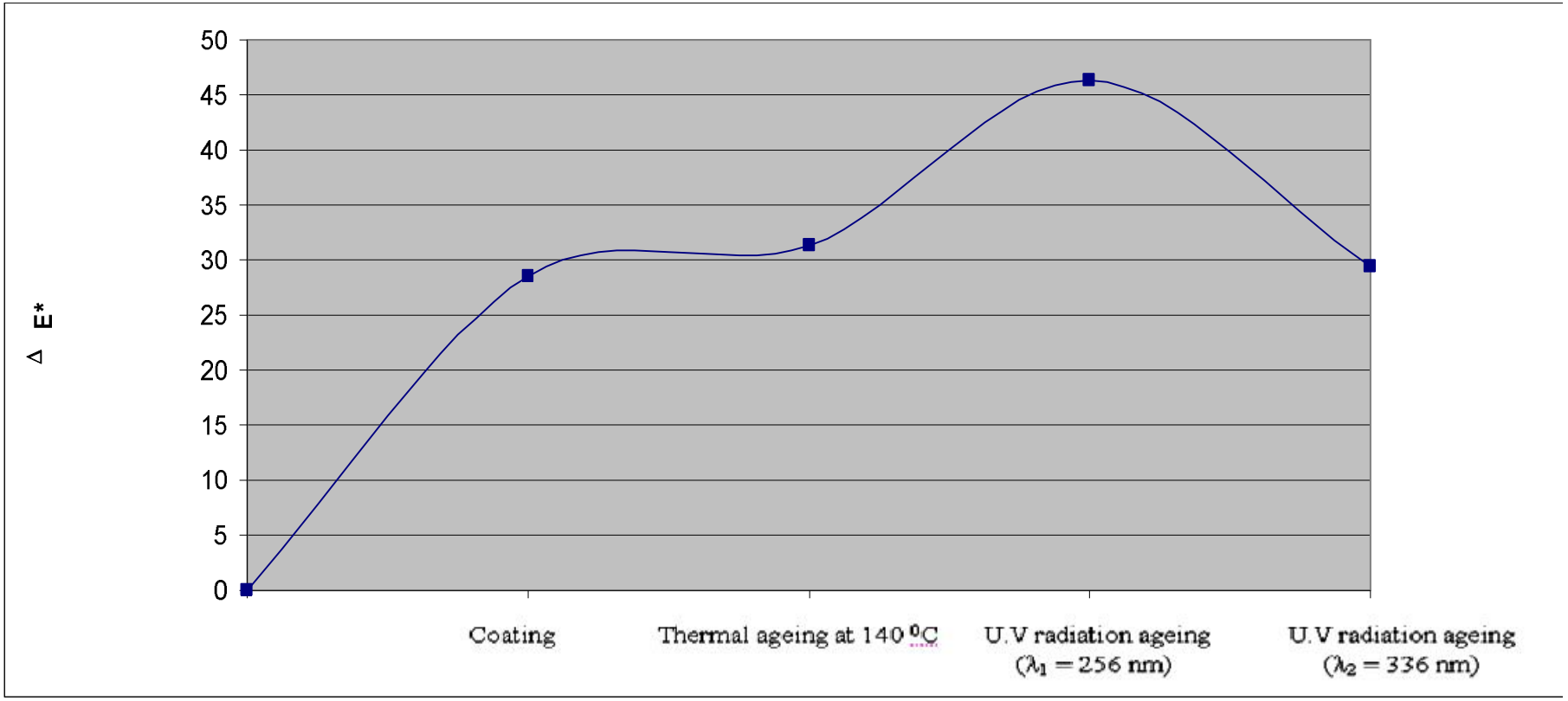

Figure 101: ΔE value of banknote paper (1 Dollar "U$") coated by 2nd L of (0.1%) Carboxymethyl cellulose (CMC) before and after ageing either by thermal ageing at 140 ^{0}C or by UV radiation (λ_1= 256 nm, λ_2 = 336 nm).*

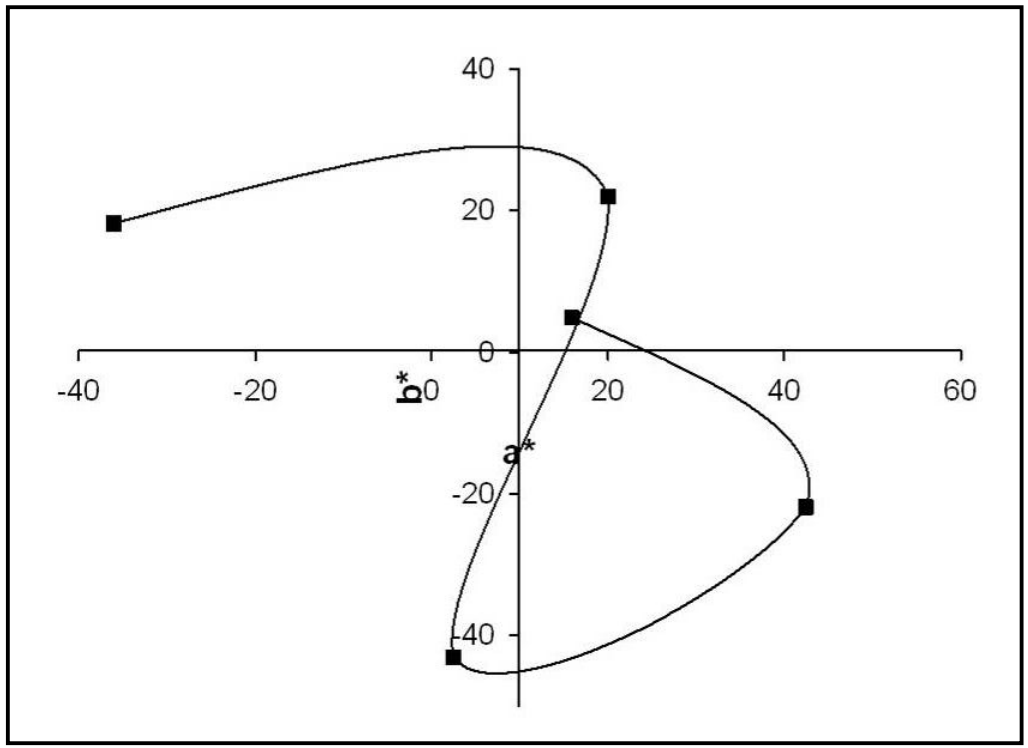

Figure 102: Effect of coating banknote paper (1 Dollar "U$") by 2nd L of (0.1%) Carboxymethyl cellulose (CMC) before and after ageing either by thermal ageing at 140 ^{0}C or by UV radiation (λ_1= 256 nm, λ_2 = 336 nm) on color change.

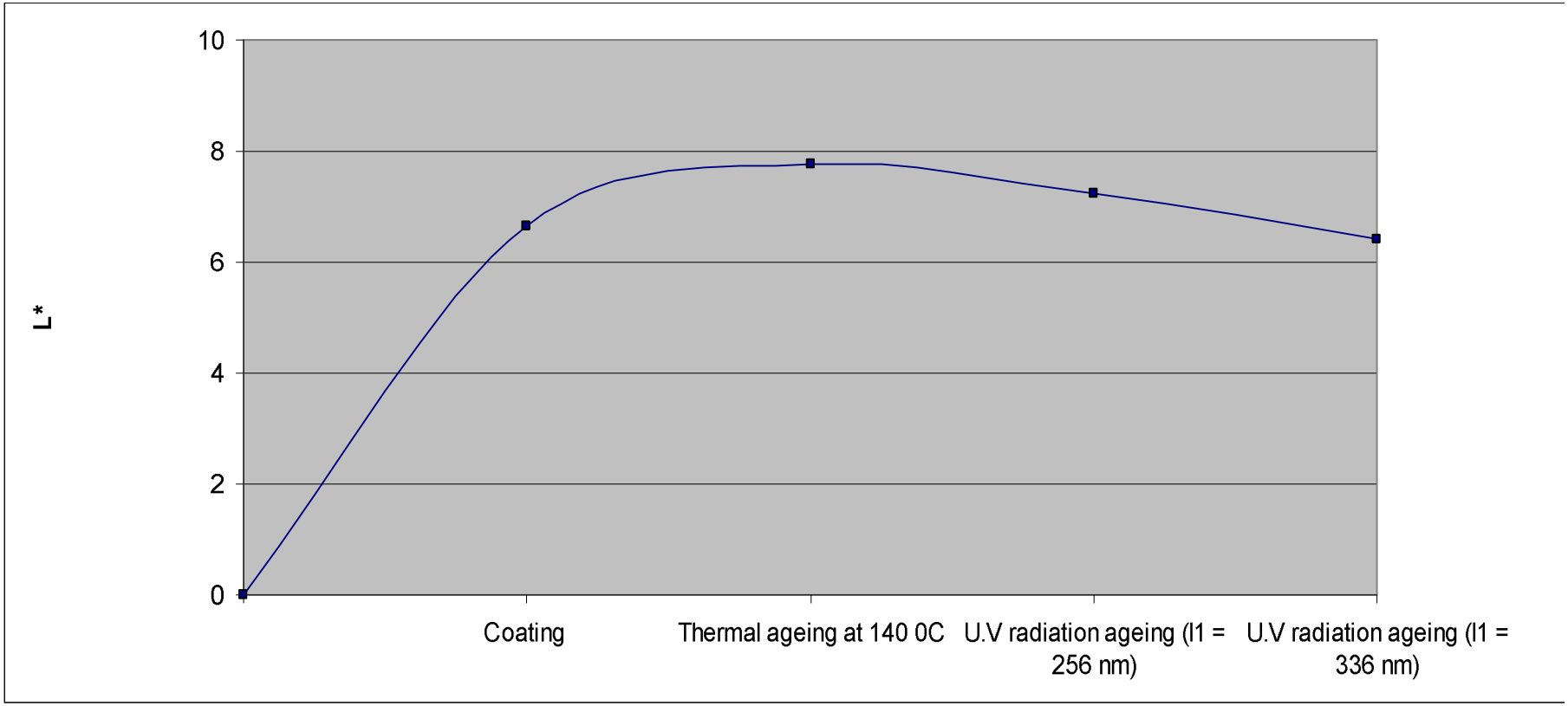

Figure 103: ΔL value of banknote paper (1 Dollar "U$") coated by 2nd L of (1%) Carboxymethyl cellulose (CMC) before and after ageing either by thermal ageing at 140 ^{0}C or by UV radiation (λ_1= 256 nm, λ_2 = 336 nm).*

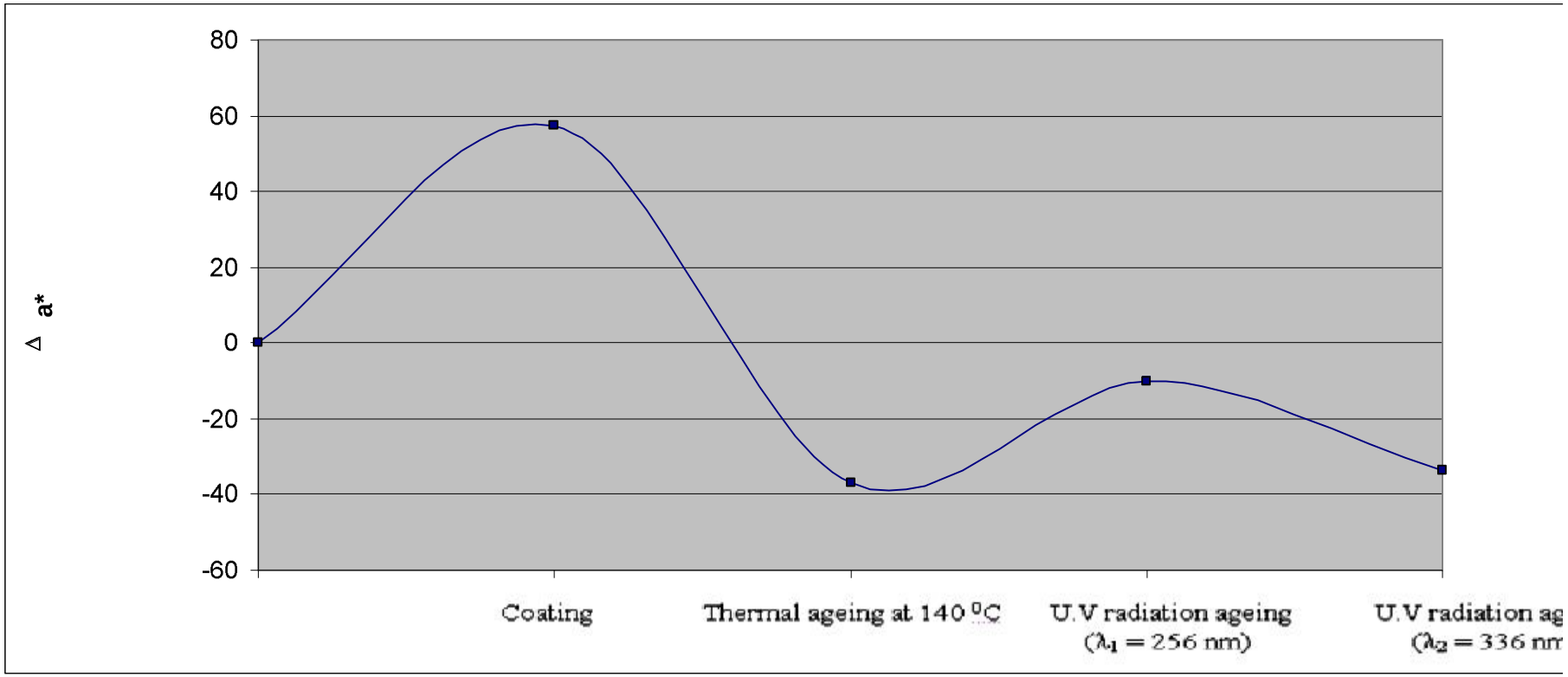

Figure 104: Δa value of banknote paper (1 Dollar "U$") coated by 2nd L of (1%) Carboxymethyl cellulose (CMC) before and after ageing either by thermal ageing at 140 ^{0}C or by UV radiation (λ_1= 256 nm, λ_2 = 336 nm).*

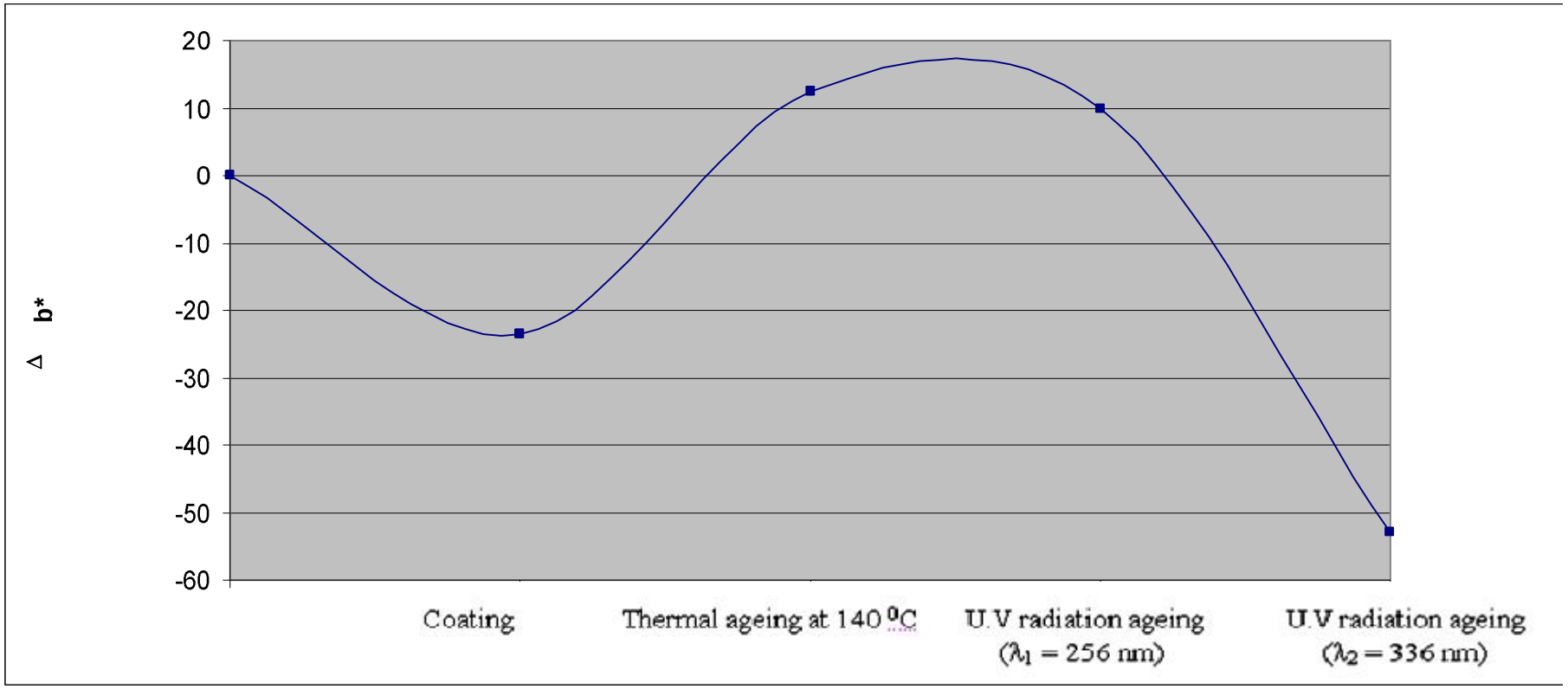

Figure 105: Δb value of banknote paper (1 Dollar "U$") coated by 2nd L of (1%) Carboxymethyl cellulose (CMC) before and after ageing either by thermal ageing at 140 ^{0}C or by UV radiation (λ_1= 256 nm, λ_2 = 336 nm).*

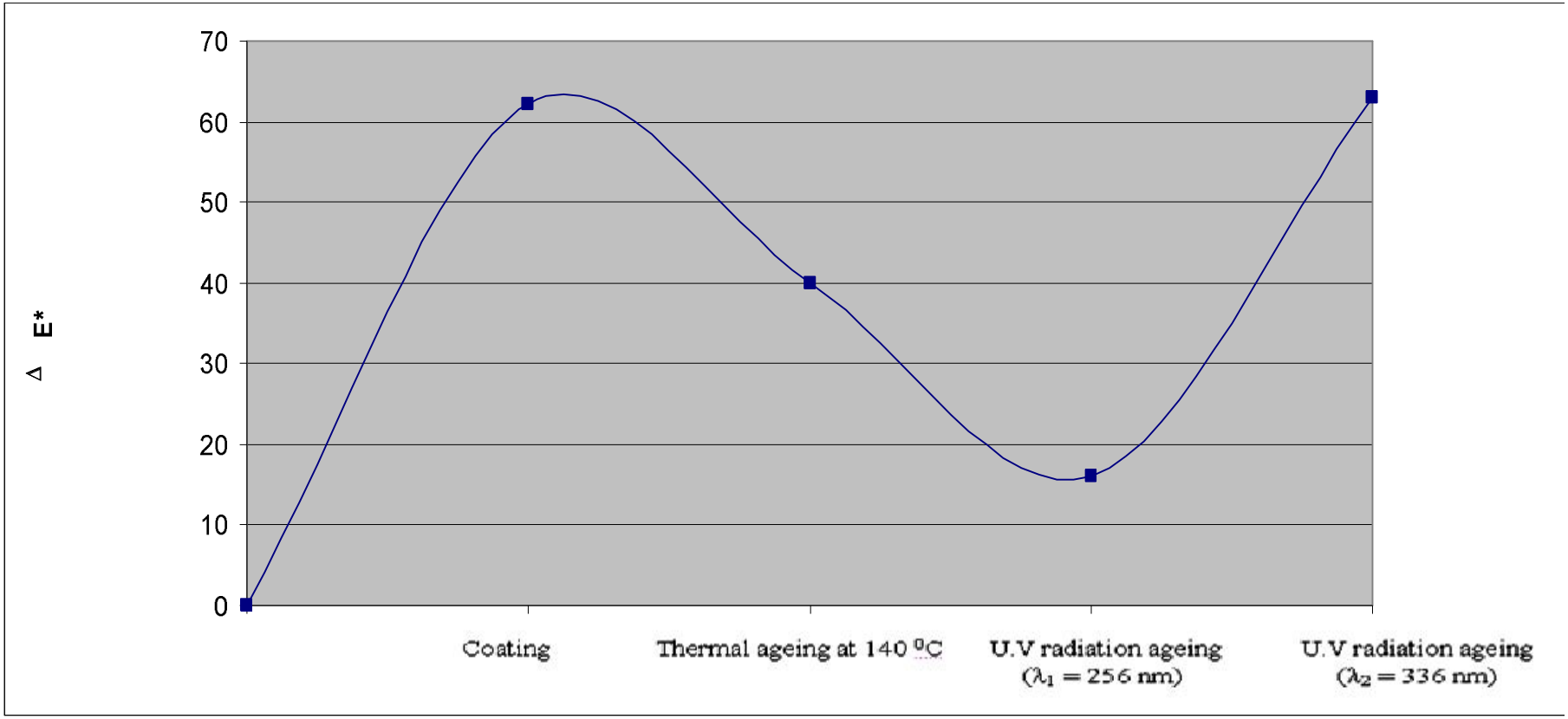

Figure 106: ΔE value of banknote paper (1 Dollar "U$") coated by 2nd L of (1%) Carboxymethyl cellulose (CMC) before and after ageing either by thermal ageing at 140 ^{0}C or by UV radiation (λ_1= 256 nm, λ_2 = 336 nm).*

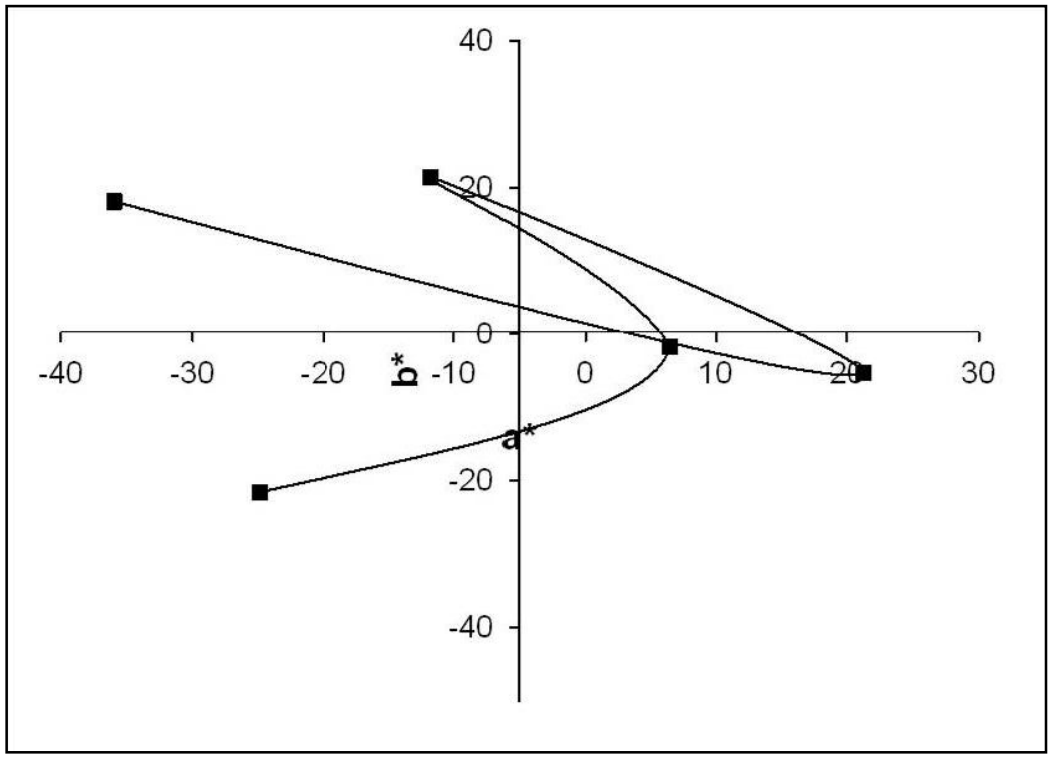

Figure 107: Effect of coating banknote paper (1 Dollar "U$") by 2nd L of (1%) Carboxymethyl cellulose (CMC) before and after ageing either by thermal ageing at 140 ^{0}C or by UV radiation (λ_1= 256 nm, λ_2 = 336 nm) on color change.

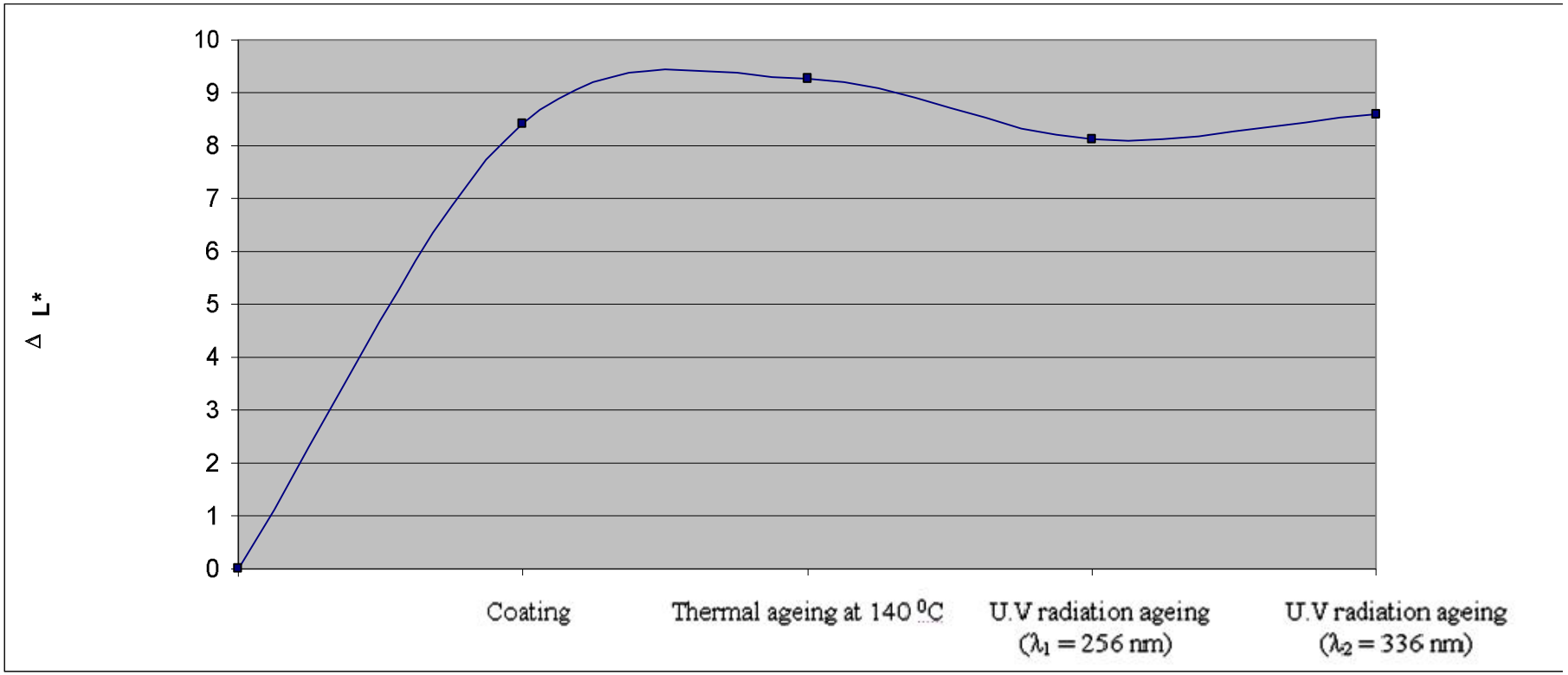

Figure 108: ΔL value of banknote paper (1 Dollar "U$") coated by 3rd L of (0.1%) Carboxymethyl cellulose (CMC) before and after ageing either by thermal ageing at 140 ^{0}C or by UV radiation (λ_1= 256 nm, λ_2 = 336 nm).*

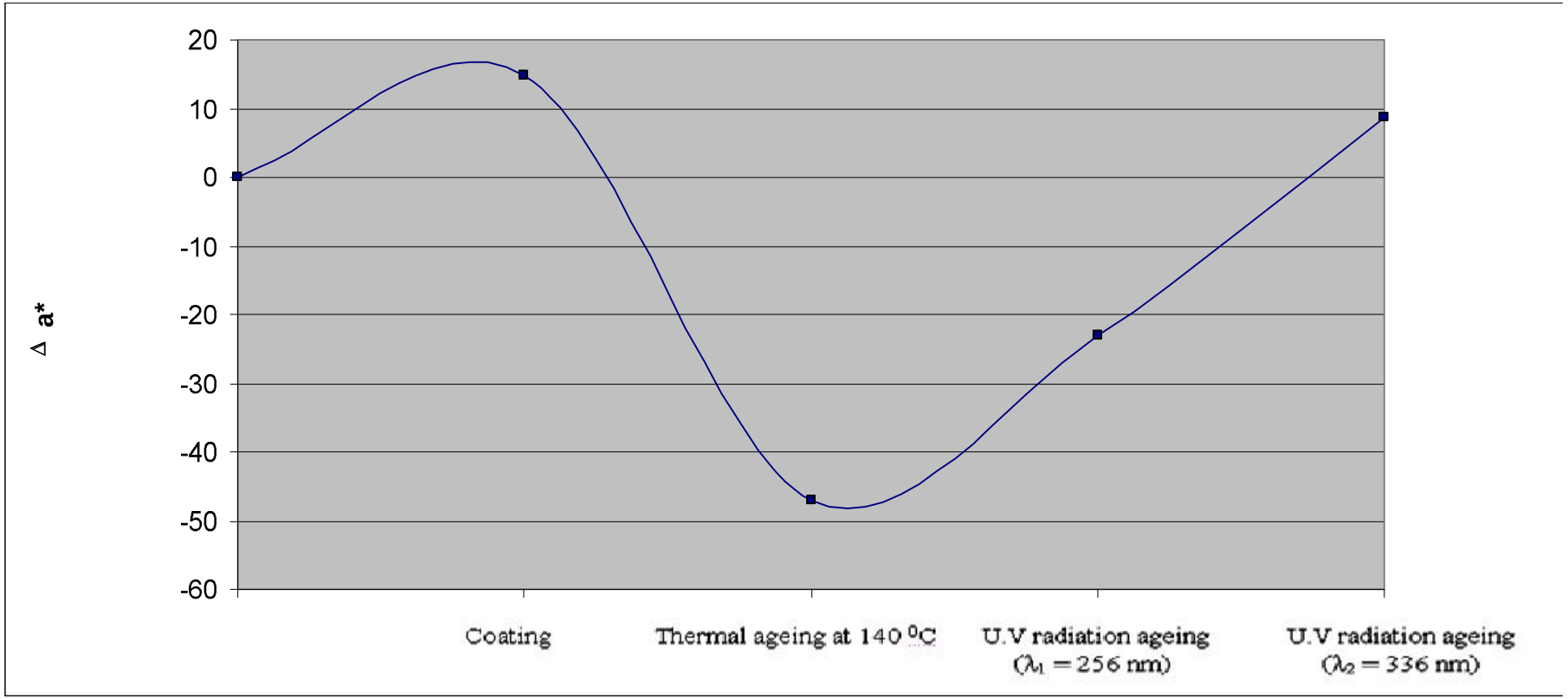

Figure 109: Δa value of banknote paper (1 Dollar "U$") coated by 3rd L of (0.1%) Carboxymethyl cellulose (CMC) before and after ageing either by thermal ageing at 140 ^{0}C or by UV radiation (λ_1= 256 nm, λ_2 = 336 nm).*

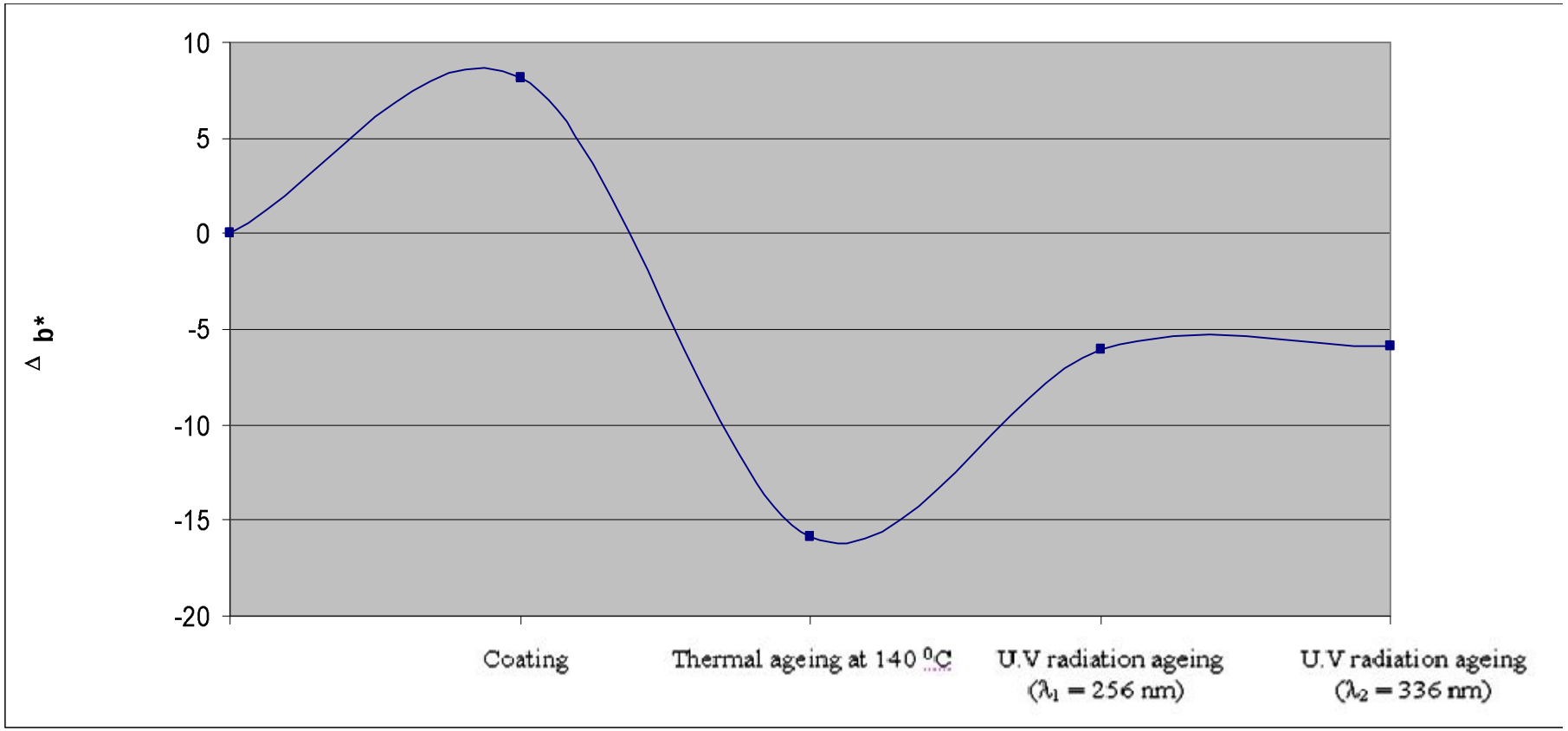

Figure 110: Δb value of banknote paper (1 Dollar "U$") coated by 3rd L of (0.1%) Carboxymethyl cellulose (CMC) before and after ageing either by thermal ageing at 140 ^{0}C or by UV radiation (λ_1= 256 nm, λ_2 = 336 nm).*

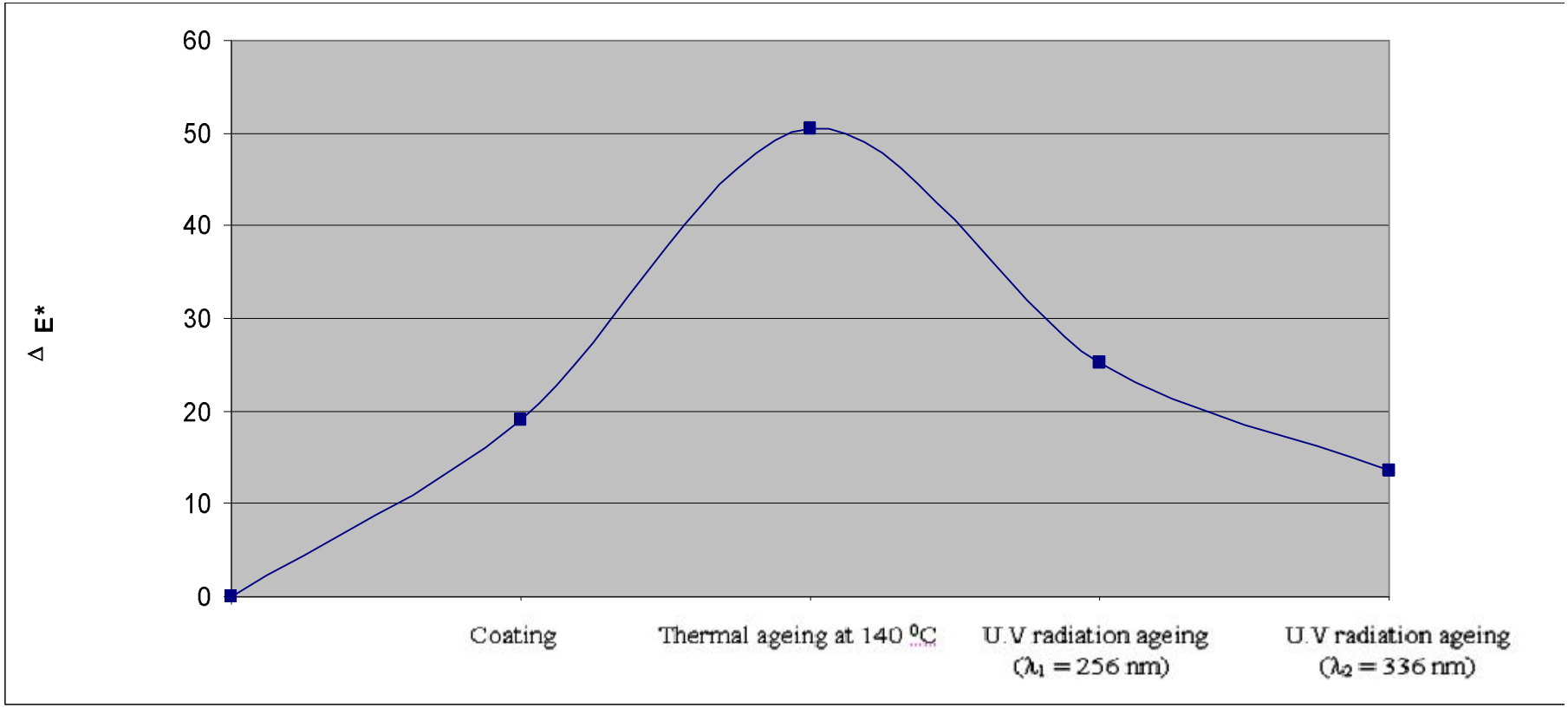

Figure 111: ΔE value of banknote paper (1 Dollar "U$") coated by 3rd L of (0.1%) Carboxymethyl cellulose (CMC) before and after ageing either by thermal ageing at 140 ^{0}C or by UV radiation (λ_1= 256 nm, λ_2 = 336 nm).*

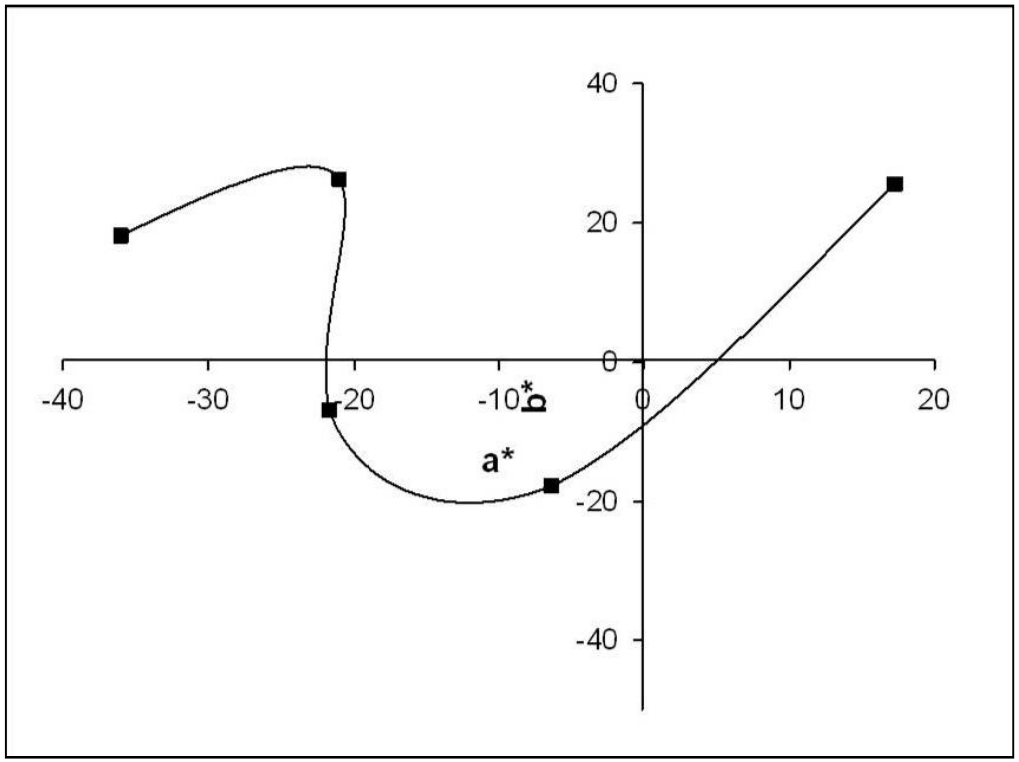

Figure 112: Effect of coating banknote paper (1 Dollar "U$") by 3rd L of (0.1%) Carboxymethyl cellulose (CMC) before and after ageing either by thermal ageing at 140 ^{0}C or by UV radiation (λ_1= 256 nm, λ_2 = 336 nm) on color change.

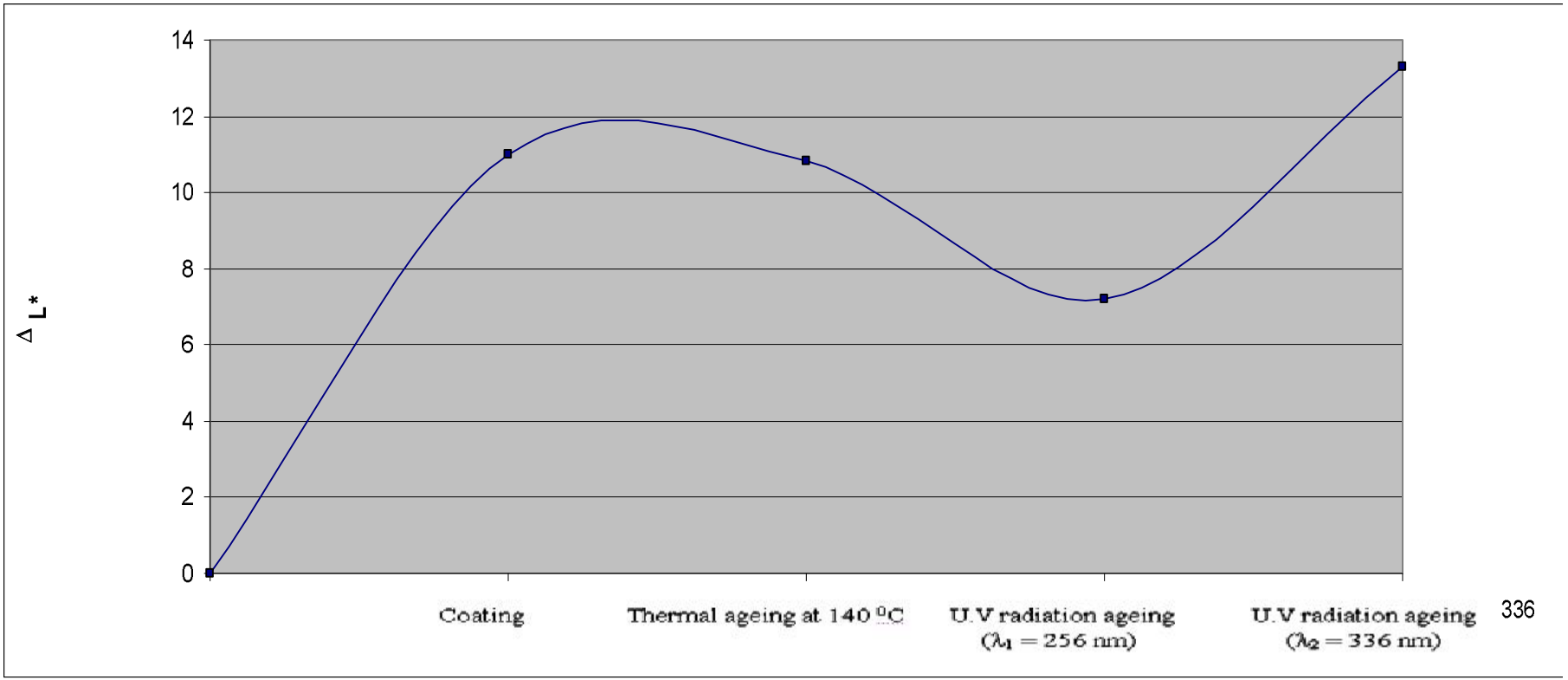

Figure 113: ΔL value of banknote paper (1 Dollar "U$") coated by 3rd L of (1%) Carboxymethyl cellulose (CMC) before and after ageing either by thermal ageing at 140 ^{0}C or by UV radiation (λ_1= 256 nm, λ_2 = 336 nm).*

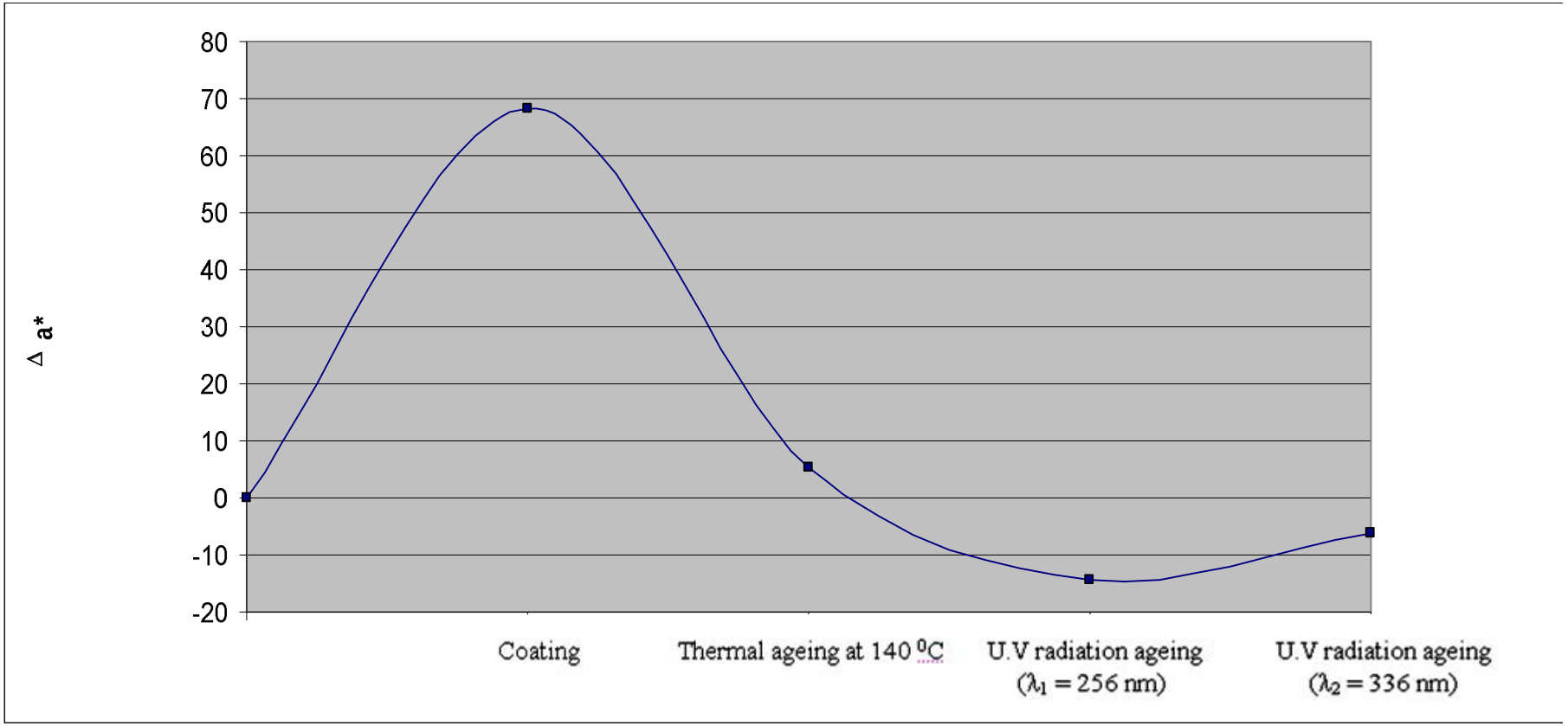

Figure 114: Δa value of banknote paper (1 Dollar "U$") coated by 3rd L of (1%) Carboxymethyl cellulose (CMC) before and after ageing either by thermal ageing at 140 ^{0}C or by UV radiation (λ_1= 256 nm, λ_2 = 336 nm).*

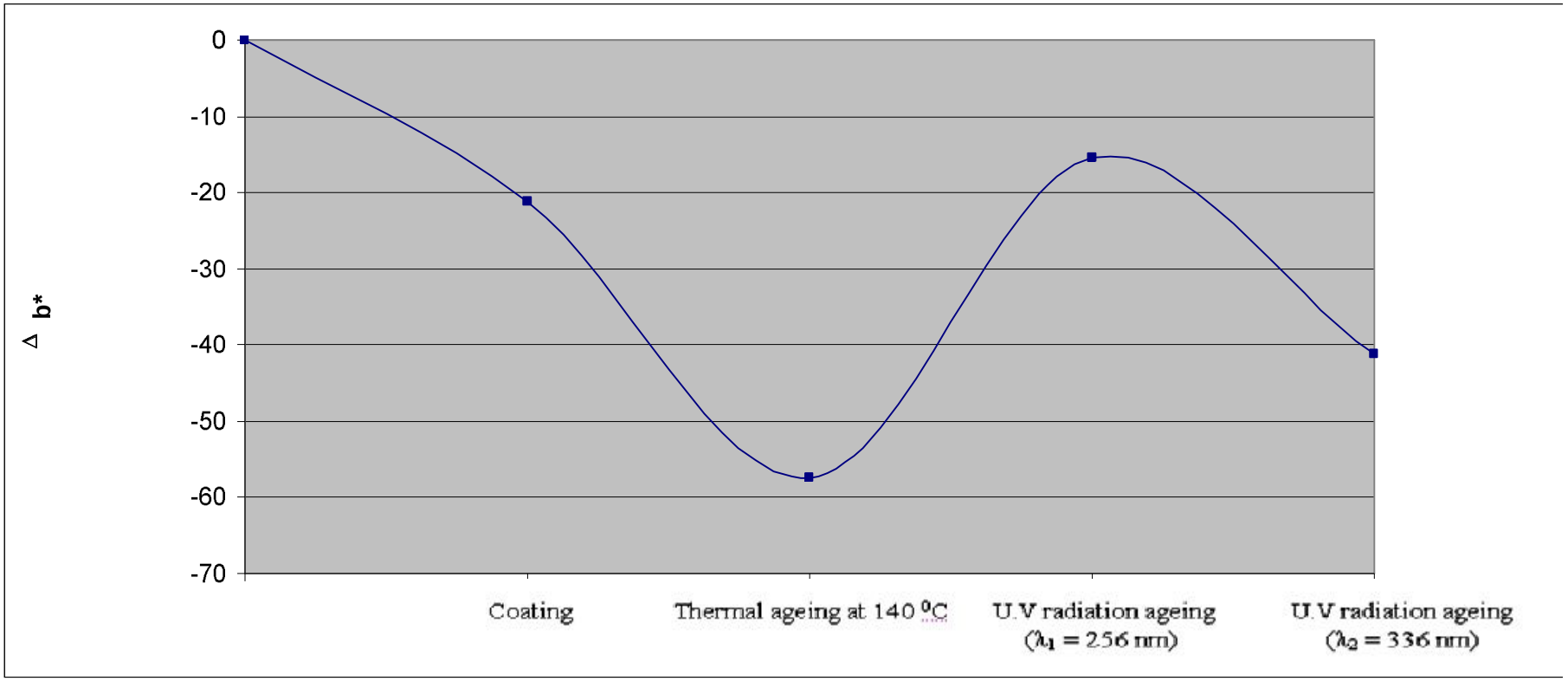

Figure 115: Δb value of banknote paper (1 Dollar "U$") coated by 3rd L of (1%) Carboxymethyl cellulose (CMC) before and after ageing either by thermal ageing at 140 ^{0}C or by UV radiation (λ_1= 256 nm, λ_2 = 336 nm).*

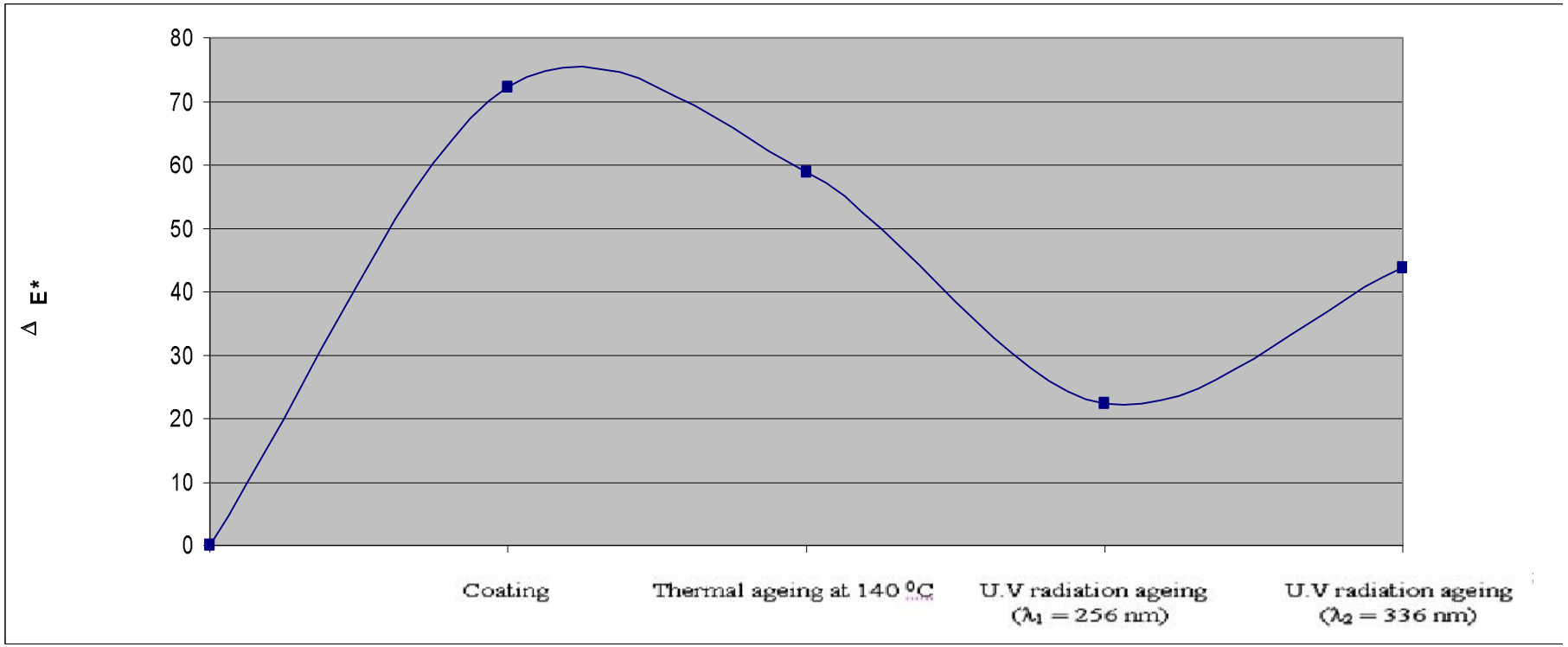

Figure 116: ΔE value of banknote paper (1 Dollar "U$") coated by 3rd L of (1%) Carboxymethyl cellulose (CMC) before and after ageing either by thermal ageing at 140 ^{0}C or by UV radiation (λ_1= 256 nm, λ_2 = 336 nm).*

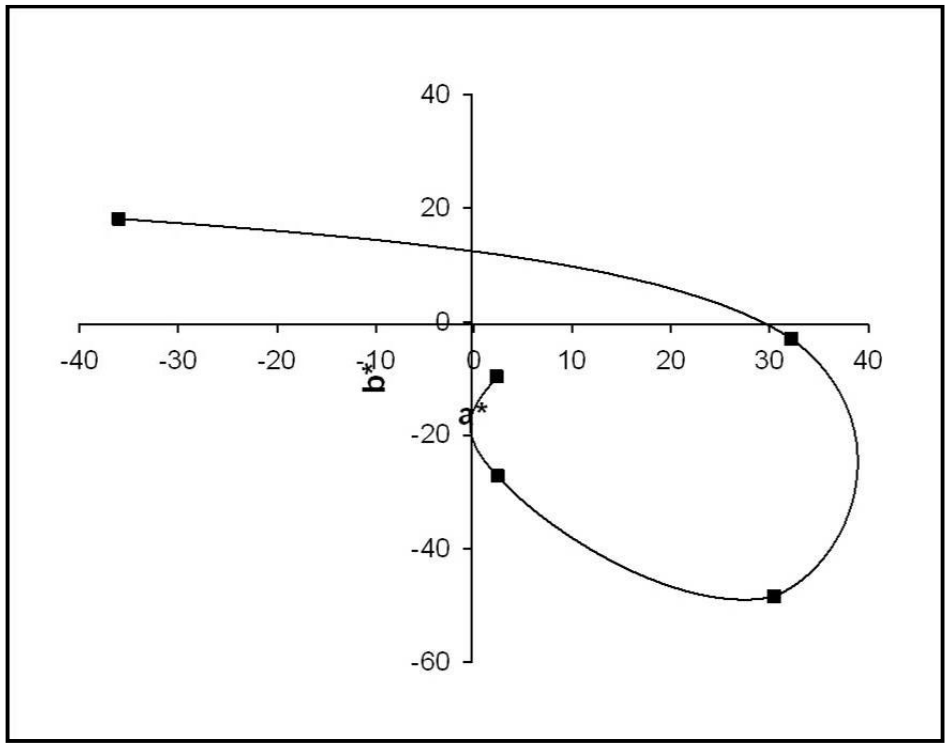

Figure 117: Effect of coating banknote paper (1 Dollar "U$") by 3rd L of (1%) Carboxymethyl cellulose (CMC) before and after ageing either by thermal ageing at 140 ^{0}C or by UV radiation (λ_1= 256 nm, λ_2 = 336 nm) on color change.

5.Photos Of Different Banknote Papers (Egyptian 5 Pounds "EGP", Egyptian 10 Pounds "EGP", 1 Riyal "SAR", 5 Dirham "AED", 1 Dollar "U$", 5 Euro "€" Through Transmitted Light

Figure 118: Paper banknote; Egyptian five pounds (5 EGP) before treatment through transmitted light (front side).

Figure 119: Paper banknote; Egyptian five pounds (5 EGP) before treatment through transmitted light (back side).

Figure 120:Paper banknote; Egyptian five pounds (5 EGP) before treatment after thermal ageing at 140 ^{0}C through transmitted light (front side).

Figure 121:Paper banknote; Egyptian five pounds (5 EGP) before treatment after thermal ageing at 140 ^{0}C through transmitted light (back side).

Figure 122:Paper banknote; Egyptian five pounds (5 EGP) before treatment under UV radiation (λ_1 = 256 nm) at 25 ^{0}C through transmitted light (front side).

Figure 123:Paper banknote; Egyptian five pounds (5 EGP) before treatment under UV radiation (λ_1 = 256 nm) at 25 ^{0}C through transmitted light (back side).

Figure 124: Paper banknote; Egyptian five pounds (5 EGP) before treatment under UV radiation (λ_2 = 336 nm) at 25 ^{0}Cthrough transmitted light (front side).

Figure 124 (a): Paper banknote; Egyptian five pounds (5 EGP) before treatment under UV radiation (λ_2 = 336 nm) at 25 ^{0}C through transmitted light (back side).

Figure 125: Paper banknote; Egyptian five pounds (5 EGP) after coating by 3rd layer of 0.1% of carboxymethyl cellulose (CMC) through transmitted light (front side).

Figure 126: Paper banknote; Egyptian five pounds (5 EGP) after coating by 3rd layer of 0.1% of carboxymethyl cellulose (CMC) through transmitted light (back side).

Figure 127: Paper banknote; Egyptian five pounds (5 EGP) after coating by 3rd layer of 0.1% of carboxymethyl cellulose (CMC) after thermal ageing at 140 ^{0}C through transmitted light (front side).

Figure 128: Paper banknote; Egyptian five pounds (5 EGP) after coating by 3rd layer of 0.1% of carboxymethyl cellulose (CMC) after thermal ageing at 140 ^{0}C through transmitted light (back side).

Figure 129: Paper banknote; Egyptian five pounds (5 EGP) after coating by 3rd layer of 0.1% of carboxymethyl cellulose (CMC) under UV radiation (λ_1 = 256 nm) at 25 ^{0}Cthrough transmitted light (front side).

Figure 130: Paper banknote; Egyptian five pounds (5 EGP) after coating by 3rd layer of 0.1% of carboxymethyl cellulose (CMC) under UV radiation (λ_1 = 256 nm) at 25 ^{0}Cthrough transmitted light (back side).

Figure 131: Paper banknote; Egyptian five pounds (5 EGP) after coating by 3rd layer of 0.1% of carboxymethyl cellulose (CMC) under UV radiation (λ_2 = 336 nm) at 25 ^{0}Cthrough transmitted light (front side).

Figure 132: Paper banknote; Egyptian five pounds (5 EGP) after coating by 3rd layer of 0.1% of carboxymethyl cellulose (CMC) under UV radiation (λ_2 = 336 nm) at 25 ^{0}Cthrough transmitted light (back side).

Figure 133: Paper banknote; Egyptian five pounds (5 EGP) after coating by 3rd layer of 1% of carboxymethyl cellulose (CMC) through transmitted light (front side).

Figure 134: Paper banknote; Egyptian five pounds (5 EGP) after coating by 3rd layer of 1% of carboxymethyl cellulose (CMC) through transmitted light (back side).

Figure 135: Paper banknote; Egyptian five pounds (5 EGP) after coating by 3rd layer of 1% of carboxymethyl cellulose (CMC) after thermal ageing at 140 ^{0}C through transmitted light (front side).

Figure 136: Paper banknote; Egyptian five pounds (5 EGP) after coating by 3rd layer of 1% of carboxymethyl cellulose (CMC) after thermal ageing at 140 ^{0}C through transmitted light (back side).

Figure 137: Paper banknote; Egyptian five pounds (5 EGP) after coating by 3rd layer of 1% of carboxymethyl cellulose (CMC) under UV radiation (λ_1 = 256 nm) through transmitted light (front side)

Figure 138: Paper banknote; Egyptian five pounds (5 EGP) after coating by 3rd layer of 1% of carboxymethyl cellulose (CMC) under UV radiation (λ_1 = 256 nm) through transmitted light (back side).

Figure 139: Paper banknote; Egyptian five pounds (5 EGP) after coating by 3rd layer of 1% of carboxymethyl cellulose (CMC) under UV radiation (λ_2 = 336 nm) through transmitted light (front side).

Figure 140: Paper banknote; Egyptian five pounds (5 EGP) after coating by 3rd layer of 1% of carboxymethyl cellulose (CMC) under UV radiation (λ_2 = 336 nm) through transmitted light (back side).

Figure 141: Paper banknote; Egyptian ten pounds (10 EGP) before treatment through transmitted light (front side)

Figure 142: Paper banknote; Egyptian ten pounds (10 EGP) before treatment through transmitted light (back side).

Figure 143: Paper banknote; Egyptian ten pounds (10 EGP) before treatment after thermal ageing at 140 ^{0}C through transmitted light (front side).

Figure 144: Paper banknote; Egyptian ten pounds (10 EGP) before treatment after thermal ageing at 140 ^{0}C through transmitted light (back side).

Figure 145: Paper banknote; Egyptian ten pounds (10 EGP) before treatment under UV radiation (λ_1 = 256 nm) at 25 ^{0}Cthrough transmitted light (front side).

Figure 146: Paper banknote; Egyptian ten pounds (10 EGP) before treatment under UV radiation (λ_1 = 256 nm) at 25 ^{0}Cthrough transmitted light (back side).

Figure 147: Paper banknote; Egyptian ten pounds (10 EGP) before treatment under UV radiation (λ_2 = 336 nm) at 25 ^{0}Cthrough transmitted light (front side)

Figure 148: Paper banknote; Egyptian ten pounds (10 EGP) before treatment under UV radiation (λ_2 = 336 nm) at 25 ^{0}Cthrough transmitted light (back side)

Figure 149: Paper banknote; Egyptian ten pounds (10 EGP) after coating by 3rd layer of 0.1% of carboxymethyl cellulose (CMC) through transmitted light (front side).

Figure 150: Paper banknote; Egyptian ten pounds (10 EGP) after coating by 3rd layer of 0.1% of carboxymethyl cellulose (CMC) through transmitted light (back side).

Figure 151: Paper banknote; Egyptian ten pounds (10 EGP) after coating by 3rd layer of 0.1% of carboxymethyl cellulose (CMC) after thermal ageing at 140 ^{0}C through transmitted light (front side).

Figure 152: Paper banknote; Egyptian ten pounds (10 EGP) after coating by 3rd layer of 0.1% of carboxymethyl cellulose (CMC) after thermal ageing at 140 ^{0}C through transmitted light (back side).

Figure 153: Paper banknote; Egyptian ten pounds (10 EGP) after coating by 3rd layer of 0.1% of carboxymethyl cellulose (CMC) under UV radiation (λ_1 = 256 nm) at 25 ^{0}Cthrough transmitted light (front side)

Figure 154: Paper banknote; Egyptian ten pounds (10 EGP) after coating by 3rd layer of 0.1% of carboxymethyl cellulose (CMC) under UV radiation (λ_1 = 256 nm) at 25 ^{0}Cthrough transmitted light (back side).

Figure 155: Paper banknote; Egyptian ten pounds (10 EGP) after coating by 3rd layer of 0.1% of carboxymethyl cellulose (CMC) under UV radiation (λ_2 = 336 nm) at 25 ^{0}Cthrough transmitted light (front side).

Figure 156: Paper banknote; Egyptian ten pounds (10 EGP) after coating by 3rd layer of 0.1% of carboxymethyl cellulose (CMC) under UV radiation (λ_2 = 336 nm) at 25 ^{0}Cthrough transmitted light (back side).

Figure 157: Paper banknote; Egyptian ten pounds (10 EGP) after coating by 3rd layer of 1% of carboxymethyl cellulose (CMC) through transmitted light (front side).

Figure 158: Paper banknote; Egyptian ten pounds (10 EGP) after coating by 3rd layer of 1% of carboxymethyl cellulose (CMC) through transmitted light (back side).

Figure 159: Paper banknote; Egyptian ten pounds (10 EGP) after coating by 3rd layer of 1% of carboxymethyl cellulose (CMC) after thermal ageing at 140 ^{0}C through transmitted light (front side).

Figure 160: Paper banknote; Egyptian ten pounds (10 EGP) after coating by 3rd layer of 1% of carboxymethyl cellulose (CMC) after thermal ageing at 140 ^{0}C through transmitted light (back side).

Figure 161: Paper banknote; Egyptian ten pounds (10 EGP) after coating by 3rd layer of 1% of carboxymethyl cellulose (CMC) under UV radiation (λ_1 = 256 nm) through transmitted light (front side).

Figure 162: Paper banknote; Egyptian ten pounds (10 EGP) after coating by 3rd layer of 1% of carboxymethyl cellulose (CMC) under UV radiation (λ_1 = 256 nm) through transmitted light (back side).

Figure 163: Paper banknote; Egyptian ten pounds (10 EGP) after coating by 3rd layer of 1% of carboxymethyl cellulose (CMC) under UV radiation (λ_2 = 336 nm) through transmitted light (front side).

Figure 164: Paper banknote; Egyptian ten pounds (10 EGP) after coating by 3rd layer of 1% of carboxymethyl cellulose (CMC) under UV radiation (λ_2 = 336 nm) through transmitted light (back side).

Figure 165: Paper banknote; One dollar (1U$) before treatment through transmitted light (front side).

Figure 166: Paper banknote; One dollar (1U$) before treatment through transmitted light (back side).

Figure 167: Paper banknote; One dollar (1U$) before treatment after thermal ageing at 140 ^{0}C through transmitted light (front side).

Figure 168: Paper banknote; One dollar (1U$) before treatment after thermal ageing at 140 ^{0}C through transmitted light (back side)

Figure 169: Paper banknote; One dollar (1U$) before treatment under UV radiation (λ_1 = 256 nm) at 25 ^{0}C through transmitted light (front side).

Figure 170: Paper banknote; One dollar (1U$) before treatment under UV radiation (λ_1 = 256 nm) at 25 ^{0}C through transmitted light (back side).

Figure 171: Paper banknote; one dollar (1U$) before treatment under UV radiation (λ_2 = 336 nm) at 25 ^{0}Cthrough transmitted light (front side).

Figure 172: Paper banknote; one dollar (1U$) before treatment under UV radiation (λ_2 = 336 nm) at 25 ^{0}Cthrough transmitted light (back side).

Figure 173: Paper banknote; one dollar (1U$) after coating by 3rd layer of 0.1% of Carboxymethyl cellulose (CMC) through transmitted light (front side).

Figure 174: Paper banknote; one dollar (1U$) after coating by 3rd layer of 0.1% of Carboxymethyl cellulose (CMC) through transmitted light (back side).

Figure 175: Paper banknote; one dollar (1U$) after coating by 3rd layer of 0.1% of Carboxymethyl cellulose (CMC) after thermal ageing 140 ^{0}C through transmitted light (front side).

Figure 176: Paper banknote; one dollar (1U$) after coating by 3rd layer of 0.1% of Carboxymethyl cellulose (CMC) after thermal ageing 140 ^{0}C through transmitted light (back side).

Figure 177: Paper banknote; one dollar (1U$) after coating by 3rd layer of 0.1% of Carboxymethyl cellulose (CMC) under UV radiation (λ_1 = 256 nm) through transmitted light (front side).

Figure 178: Paper banknote; one dollar (1U$) after coating by 3rd layer of 0.1% of Carboxymethyl cellulose (CMC) under UV radiation (λ_1 = 256 nm) through transmitted light (back side).

Figure 179: Paper banknote; one dollar (1U$) after coating by 3rd layer of 0.1% of Carboxymethyl cellulose (CMC) under UV radiation (λ_2 = 336 nm) through transmitted light (front side).

Figure 180: Paper banknote; one dollar (1U$) after coating by 3rd layer of 0.1% of Carboxymethyl cellulose (CMC) under UV radiation (λ_2 = 336 nm) through transmitted light (back side).

Figure 181: Paper banknote; one dollar (1U$) after coating by 3rd layer of 1% of Carboxymethyl cellulose (CMC) through transmitted light (front side).

Figure 182: Paper banknote; one dollar (1U$) after coating by 3rd layer of 1% of Carboxymethyl cellulose (CMC) through transmitted light (back side).

Figure 183: Paper banknote; one dollar (1U$) after coating by 3rd layer of 1% of Carboxymethyl cellulose (CMC) after thermal ageing 140 ^{0}C through transmitted light (front side).

Figure 184: Paper banknote; one dollar (1U$) after coating by 3rd layer of 1% of Carboxymethyl cellulose (CMC) after thermal ageing 140 ^{0}C through transmitted light (back side).

Figure 185: Paper banknote; one dollar (1U$) after coating by 3rd layer of 1 % of Carboxymethyl cellulose (CMC) under UV radiation (λ_1 = 256 nm) through transmitted light (front side).

Figure 186: Paper banknote; one dollar (1U$) after coating by 3rd layer of 1 % of Carboxymethyl cellulose (CMC) under UV radiation (λ_1 = 256 nm) through transmitted light (back side).

Figure 187: Paper banknote; one dollar (1U$) after coating by 3rd layer of 1 % of Carboxymethyl cellulose (CMC) under UV radiation (λ_2 = 336 nm) through transmitted light (front side).

Figure 188: Paper banknote; one dollar (1U$) after coating by 3rd layer of 1 % of Carboxymethyl cellulose (CMC) under UV radiation (λ_2 = 336 nm) through transmitted light (back side).

Figure 189: Paper banknote; one riyal (1 SAR) before treatment through transmitted light (front side).

Figure 190: Paper banknote; one riyal (1 SAR) before treatment through transmitted light (back side).

Figure 191: Paper banknote; one riyal (1 SAR) before treatment after thermal ageing at 140 ^{0}C through transmitted light (front side).

Figure 192: Paper banknote; one riyal (1 SAR) before treatment after thermal ageing at 140 ^{0}C through transmitted light (back side).

Figure 193: Paper banknote; one riyal (1 SAR) before treatment under UV radiation (λ_1 = 256 nm) through transmitted light (front side).

Figure 194: Paper banknote; one riyal (1 SAR) before treatment under UV radiation (λ_1 = 256 nm) through transmitted light (back side).

Figure 195: Paper banknote; one riyal (1 SAR) before treatment under UV radiation (λ_2 = 336 nm) through transmitted light (front side).

Figure (196): Paper banknote; one riyal (1 SAR) before treatment under UV radiation (λ_2 = 336 nm) through transmitted light (back side).

Figure 197: Paper banknote; one riyal (1 SAR) after coating by 3rd layer of 1% carboxymethyl cellulose (CMC) through transmitted light (front side).

Figure 198: Paper banknote; one riyal (1 SAR) after coating by 3rd layer of 1% carboxymethyl cellulose (CMC) through transmitted light (back side).

Figure199: Paper banknote; one riyal (1 SAR) after coating by 3rd layer of 1% carboxymethyl cellulose (CMC) after thermal ageing at 140 ^{0}C through transmitted light (front side).

Figure 200: Paper banknote; one riyal (1 SAR) after coating by 3rd layer of 1% carboxymethyl cellulose (CMC) after thermal ageing at 140 ^{0}C through transmitted light (front side).

Figure 201: Paper banknote; one riyal (1 SAR) after coating by 3rd layer of 1% carboxymethyl cellulose (CMC) under UV radiation (λ_1 = 256 nm) through transmitted light (front side).

Figure 202: Paper banknote; one riyal (1 SAR) after coating by 3rd layer of 1% carboxymethyl cellulose (CMC) under UV radiation (λ_1 = 256 nm) through transmitted light (back side).

Figure 203: Paper banknote; one Riyal (1 SAR) after coating by 3rd layer of 1% of carboxymethyl cellulose (CMC) under UV radiation (λ2 = 336 nm) through transmitted light (front side).

Figure 204: Paper banknote; one Riyal (1 SAR) after coating by 3rd layer of 1% of carboxymethyl cellulose (CMC) under UV radiation (λ_2 = 336 nm) through transmitted light (back side).

Figure 205: Paper banknote; five Dirhams (5 AED) before treatment through transmitted light (front side).

Figure (206): Paper banknote; five Dirhams (5 AED) before treatment through transmitted light (back side).

Figure 207: Paper banknote; five Dirhams (5 AED) before treatment after thermal ageing at 140 ^{0}C through transmitted light (front side).

Figure 208: Paper banknote; five Dirhams (5 AED) before treatment after thermal ageing at 140 ^{0}C through transmitted light (back side)

Figure (209): Paper banknote; five Dirhams (5 AED) before treatment under UV radiation (λ_1 = 256 nm) through transmitted light (front side).

Figure 210: Paper banknote; five Dirhams (5 AED) before treatment under UV radiation (λ_1 = 256 nm) through transmitted light (back side).

Figure 211: Paper banknote; five Dirhams (5 AED) before treatment under UV radiation (λ_2 = 336 nm) through transmitted light (front side)

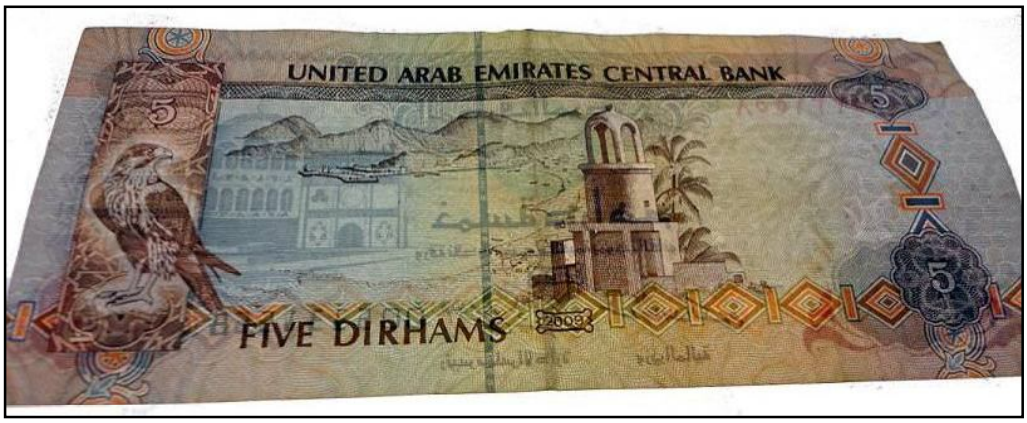

Figure 212: Paper banknote; five Dirhams (5 AED) before treatment under UV radiation (λ_2 = 336 nm) through transmitted light (back side).

Figure 213: Paper banknote; five Dirhams (5 AED) after coating by 3rd layer of 1% of carboxymethyl cellulose (CMC) through transmitted light (front side).

Figure 214: Paper banknote; five Dirhams (5 AED) after coating by 3rd layer of 1% of carboxymethyl cellulose (CMC) through transmitted light (back side).

Figure 215: Paper banknote; five Dirhams (5 AED) after coating by 3rd layer of 1% of carboxymethyl cellulose (CMC) after thermal ageing at 140 ^{0}C through transmitted light (front side).

Figure 216: Paper banknote; five Dirhams (5 AED) after coating by 3rd layer of 1% of carboxymethyl cellulose (CMC) after thermal ageing at 140 ^{0}C through transmitted light (back side).

Figure 217: Paper banknote; five Dirhams (5 AED) after coating by 3rd layer of 1% carboxymethyl cellulose (CMC) of 1% under UV radiation (λ_1 = 256 nm) through transmitted light (front side)

Figure 218: Paper banknote; five Dirhams (5 AED) after coating by 3rd layer of 1% carboxymethyl cellulose (CMC) of 1% under UV radiation (λ_1 = 256 nm) through transmitted light (back side).

Figure 219: Paper banknote; five Dirhams (5 AED) after coating by 3rd layer of 1% carboxymethyl cellulose (CMC) of 1% under UV radiation (λ_2 = 336 nm) through transmitted light (front side).

Figure 220: Paper banknote; five Dirhams (5 AED) after coating by 3rd layer of 1% carboxymethyl cellulose (CMC) of 1% under UV radiation (λ_2 = 336 through (nm .(back side)transmitted light

Figure 221: Paper banknote; five Euro (5 €) before treatment through transmitted light (front side)

Figure 222: Paper banknote; five Euro (5 €) before treatment through transmitted light (back side)

Figure 223: Paper banknote; five Euro (5 €) before treatment after thermal ageing at 140 ^{0}C through transmitted light (front side).

Figure 224: Paper banknote; five Euro (5 €) before treatment after thermal ageing at 140 ^{0}C through transmitted light (back side).

Figure 225: Paper banknote; five Euro (5 €) before treatment under UV radiation (λ_1 = 256 nm) at 25 ^{0}Cthrough transmitted light (front side).

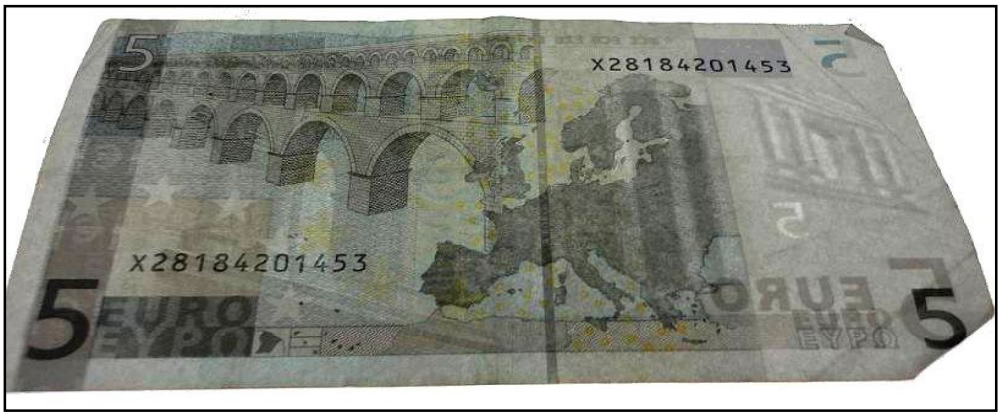

Figure 226: Paper banknote; five Euro (5 €) before treatment under UV radiation (λ_1 = 256 nm) at 25 ^{0}Cthrough transmitted light (back side).

Figure 227: Paper banknote; five Euro (5 €) before treatment under UV radiation (λ_2 = 336 nm) at 25 ^{0}Cthrough transmitted light (front side)

Figure 228: Paper banknote; five Euro (5 €) before treatment under UV radiation (λ_2 = 336 nm) at 25 ^{0}Cthrough transmitted light (back side)

Figure 229: Paper banknote; five Euro (5 €) after coating by 3rd layer of 1% carboxymethyl cellulose (CMC) through transmitted light (front side).

Figure 230: Paper banknote; five Euro (5 €) after coating by 3rd layer of 1% carboxymethyl cellulose (CMC) through transmitted light (back side)

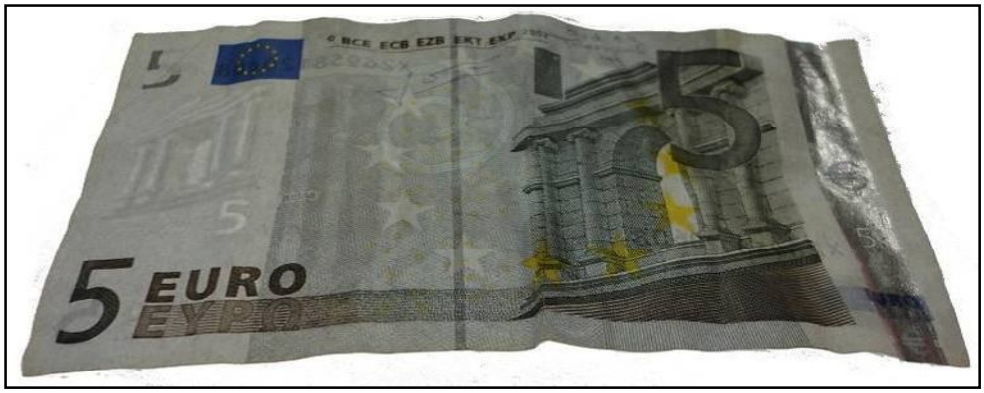

Figure 231: Paper banknote; five Euro (5 €) after coating by 3rd layer of 1% carboxymethyl cellulose (CMC) after thermal ageing at 140 ^{0}C through transmitted light (front side)

Figure 232: Paper banknote; five Euro (5 €) after coating by 3rd layer of 1% carboxymethyl cellulose (CMC) after thermal ageing at 140 ^{0}C through transmitted light (back side).

Figure 233: Paper banknote; five Euro (5 €) after coating by 3rd layer of 1% carboxymethyl cellulose (CMC) under UV radiation (λ_1 = 256 nm) at 25 ^{0}Cthrough transmitted light (front side).

Figure 234: Paper banknote; five Euro (5 €) after coating by 3rd layer of 1% carboxymethyl cellulose (CMC) under UV radiation (λ_1 = 256 nm) at 25 ^{0}Cthrough transmitted light (back side).

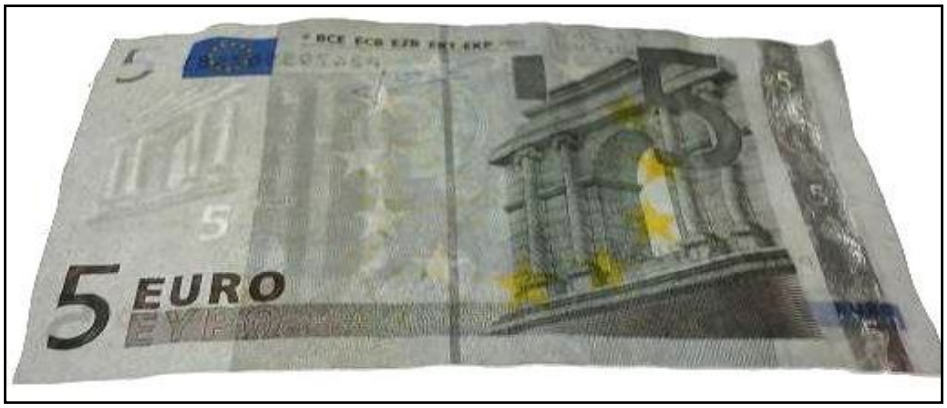

Figure 235: Paper banknote; five Euro (5 €) after coating by 3rd layer of 1% carboxymethyl cellulose (CMC) under UV radiation (λ_2 = 336 nm) at 25 ^{0}Cthrough transmitted light (front side).

Figure 236: Paper banknote; five Euro (5 €) after coating by 3rd layer of 1% carboxymethyl cellulose (CMC) under UV radiation (λ_2 = 336 nm) at 25 ^{0}C through transmitted light (back side).

6.Photos Of Different Banknote Papers (Egyptian 5 Pounds "EGP", Egyptian 10 Pounds "EGP", 1 Riyal "SAR", 5 Dirham "AED", 1 Dollar "U$", 5 Euro "€") Through UV Radiation

Figure 237: Paper banknote; Egyptian five pounds (5 EGP) before treatment through UV radiation (front side)

Figure 238: Paper banknote; Egyptian five pounds (5 EGP) before treatment through UV radiation (back side).

Figure 239: Paper banknote; Egyptian five pounds (5 EGP) before treatment after thermal ageing at 140 ^{0}C through UV radiation (front side).

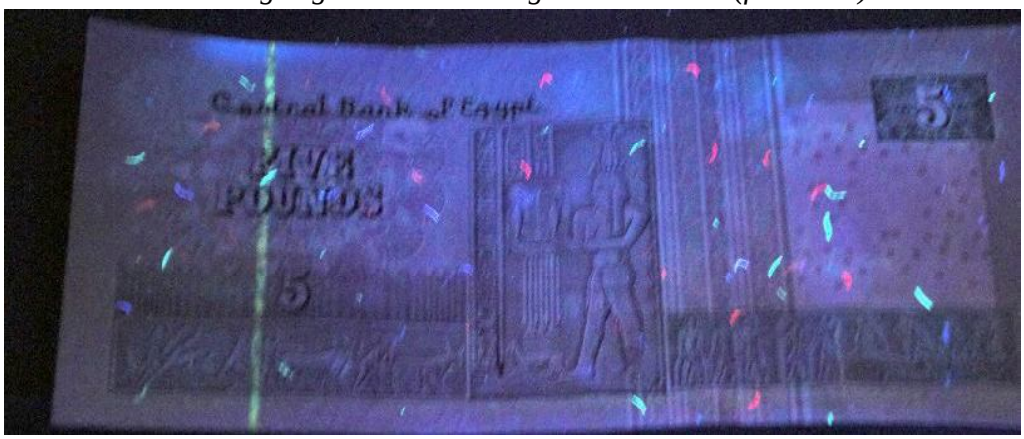

Figure 240: Paper banknote; Egyptian five pounds (5 EGP) before treatment after thermal ageing at 140 ^{0}C through UV radiation (back side).

Figure 241: Paper banknote; Egyptian five pounds (5 EGP) before treatment under UV radiation (λ_1 = 256 nm) at 25 ^{0}C through UV radiation (front side).

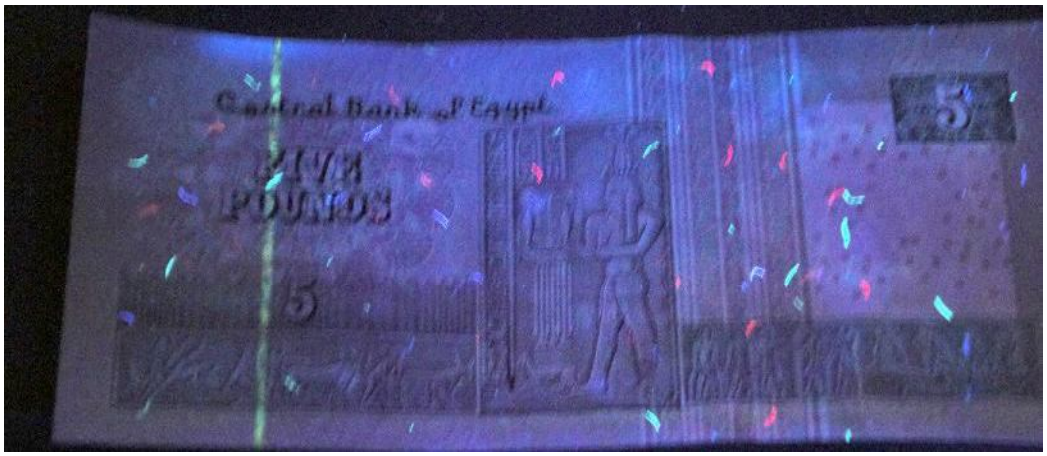

Figure 242: Paper banknote; Egyptian five pounds (5 EGP) before treatment under UV radiation (λ_1 = 256 nm) at 25 ^{0}C through UV radiation (back side).

Figure 243: Paper banknote; Egyptian five pounds (5 EGP) before treatment under UV radiation (λ_2 = 336 nm) at 25 ^{0}Cthrough UV radiation (front side).

Figure 244: Paper banknote; Egyptian five pounds (5 EGP) before treatment under UV radiation (λ_2 = 336 nm) at 25 ^{0}C through UV radiation (back side).

Figure 245: Paper banknote; Egyptian five pounds (5 EGP) after coating by 3rd layer of 1% of carboxymethyl cellulose (CMC) through UV radiation (front side).

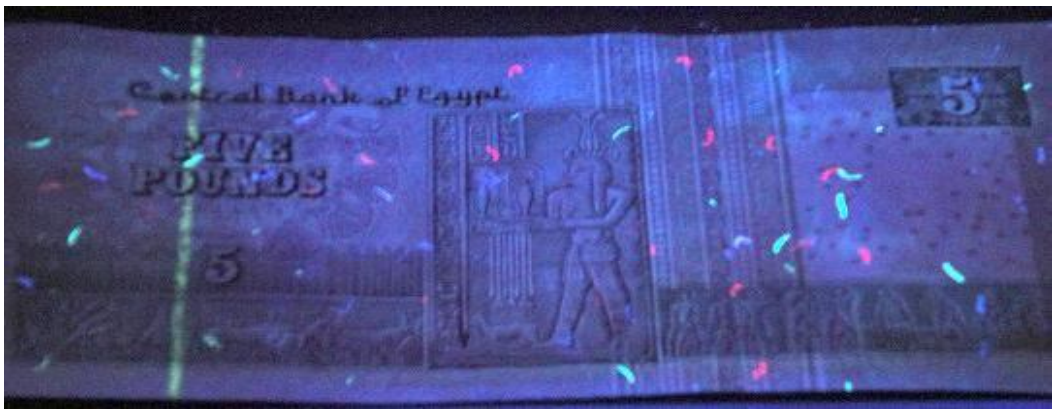

Figure 246: Paper banknote; Egyptian five pounds (5 EGP) after coating by 3rd layer of 1% of carboxymethyl cellulose (CMC) through UV radiation (back side).

Figure 247: Paper banknote; Egyptian five pounds (5 EGP) after coating by 3rd layer of 1% of carboxymethyl cellulose (CMC) after thermal ageing at 140 ^{0}C through UV radiation (front side).

Figure 248: Paper banknote; Egyptian five pounds (5 EGP) after coating by 3rd layer of 1% of carboxymethyl cellulose (CMC) after thermal ageing at 140 ^{0}C through UV radiation (back side).

Figure 249: Paper banknote; Egyptian five pounds (5 EGP) after coating by 3rd layer of 1% of carboxymethyl cellulose (CMC) under UV radiation (λ_1 = 256 nm) at 25 ^{0}Cthrough UV radiation (front side)

Figure 250: Paper banknote; Egyptian five pounds (5 EGP) after coating by 3rd layer of 1% of carboxymethyl cellulose (CMC) under UV radiation (λ_1 = 256 nm) at 25 ^{0}Cthrough UV radiation (back side).

Figure 251: Paper banknote; Egyptian five pounds (5 EGP) after coating by 3rd layer of 1% of carboxymethyl cellulose (CMC) under UV radiation (λ_2 = 336 nm) at 25 ^{0}C through UV radiation (front side)

Figure 252: Paper banknote; Egyptian five pounds (5 EGP) after coating by 3rd layer of 1% of carboxymethyl cellulose (CMC) under UV radiation (λ_2 = 336 nm) at 25 ^{0}Cthrough UV radiation (back side).

Figure 253: Paper banknote; Egyptian ten pounds (10 EGP) before treatment through UV radiation (front side).

Figure 254: Paper banknote; Egyptian ten pounds (10 EGP) before treatment through UV radiation (back side).

Figure 255: Paper banknote; Egyptian ten pounds (10 EGP) before treatment after thermal ageing at 140 ^{0}C through UV radiation (front side).

Figure 256: Paper banknote; Egyptian ten pounds (10 EGP) before treatment after thermal ageing at 140 ^{0}C through UV radiation (back side).

Figure (257): Paper banknote; Egyptian ten pounds (10 EGP) before treatment under UV radiation (λ_1 = 256 nm) at 25 ^{0}C through UV radiation (front side).

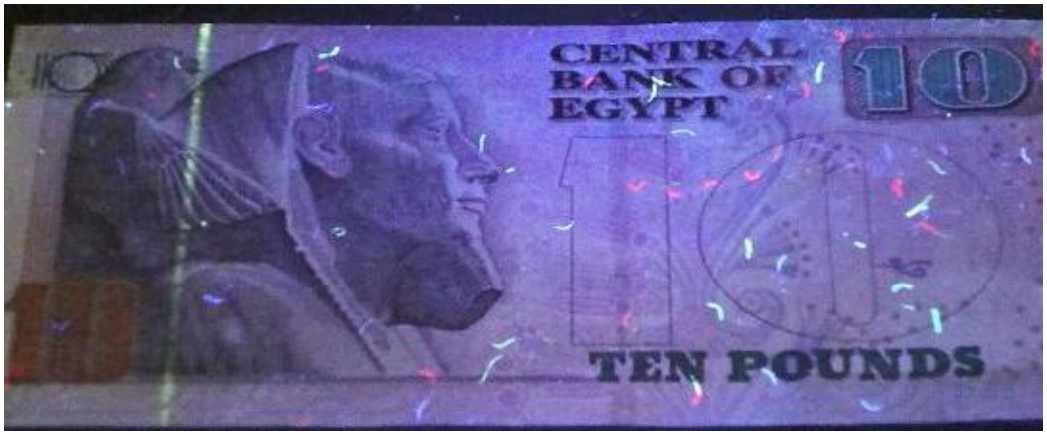

Figure 258: Paper banknote; Egyptian ten pounds (10 EGP) before treatment under UV radiation (λ_1 = 256 nm) at 25 ^{0}C through UV radiation (back side).

Figure 259: Paper banknote; Egyptian ten pounds (10 EGP) before treatment under UV radiation (λ_2 = 336 nm) at 25 ^{0}Cthrough UV radiation (front side).

Figure 260: Paper banknote; Egyptian ten pounds (10 EGP) before treatment under UV radiation (λ_2 = 336 nm) at 25 ^{0}Cthrough UV radiation (back side).

Figure 261: Paper banknote; Egyptian ten pounds (10 EGP) after coating by 3rd layer of 1% of carboxymethyl cellulose (CMC) through UV radiation (front side).

Figure 262: Paper banknote; Egyptian ten pounds (10 EGP) after coating by 3rd layer of 1% of carboxymethyl cellulose (CMC) through UV radiation (back side).

Figure 263: Paper banknote; Egyptian ten pounds (10 EGP) after coating by 3rd layer of 1% of carboxymethyl cellulose (CMC) after thermal ageing at 140 ^{0}C through UV radiation (front side)

Figure 264: Paper banknote; Egyptian ten pounds (10 EGP) after coating by 3rd layer of 1% of carboxymethyl cellulose (CMC) after thermal ageing at 140 ^{0}C through UV radiation (back side).

Figure 265: Paper banknote; Egyptian ten pounds (10 EGP) after coating by 3rd layer of 1% of carboxymethyl cellulose (CMC) under UV radiation (λ_1 = 256 nm) at 25 ^{0}Cthrough UV radiation (front side).

Figure 266: Paper banknote; Egyptian ten pounds (10 EGP) after coating by 3rd layer of 1% of carboxymethyl cellulose (CMC) under UV radiation (λ_1 = 256 nm) at 25 ^{0}Cthrough UV radiation (back side).

Figure 267: Paper banknote; Egyptian ten pounds (10 EGP) after coating by 3rd layer of 1% of carboxymethyl cellulose (CMC) under UV radiation (λ_2 = 336 nm) at 25 ^{0}Cthrough UV radiation (front side).

Figure (268): Paper banknote; Egyptian ten pounds (10 EGP) after coating by 3rd layer of 1% of carboxymethyl cellulose (CMC) under UV radiation (λ_2 = 336 nm) at 25 ^{0}Cthrough UV radiation (back side).

Figure 269: Paper banknote; One dollar (1U$) before treatment through UV radiation (front side).

Figure 270: Paper banknote; One dollar (1U$) before treatment through UV radiation (back side).

Figure 271: Paper banknote; One dollar (1U$) before treatment after thermal ageing at 140 ^{0}C through UV radiation (front side).

Figure (272): Paper banknote; One dollar (1U$) before treatment after thermal ageing at 140 ^{0}C through UV radiation (back side).

Figure 273: Paper banknote; One dollar (1U$) before treatment under UV radiation (λ_1 = 256 nm) at 25 ^{0}C through UV radiation (front side).

Figure 274: Paper banknote; One dollar (1U$) before treatment under UV radiation (λ_1 = 256 nm) at 25 ^{0}C through UV radiation (back side).

Figure 275: Paper banknote; One dollar (1U$) before treatment under UV radiation (λ_2 = 336 nm) at 25 ^{0}Cthrough UV radiation (front side).

Figure (276): Paper banknote; One dollar (1U$) before treatment under UV radiation (λ_2 = 336 nm) at 25 ^{0}Cthrough UV radiation (back side).

Figure 277: Paper banknote; One dollar (1U$) after coating by 3rd layer of 1% of carboxymethyl cellulose (CMC) through UV radiation (front side).

Figure 278: Paper banknote; One dollar (1U$) after coating by 3rd layer of 1% of carboxymethyl cellulose (CMC) through UV radiation (back side).

Figure 279: Paper banknote; One dollar (1U$) after coating by 3rd layer of 1% of carboxymethyl cellulose (CMC) after thermal ageing at 140 ^{0}C through UV radiation (front side).

Figure 280: Paper banknote; One dollar (1U$) after coating by 3rd layer of 1% of carboxymethyl cellulose (CMC) after thermal ageing at 140 ^{0}C through UV radiation (back side).

Figure 281: Paper banknote; One dollar (1U$) after coating by 3rd layer of 1% of carboxymethyl cellulose (CMC) under UV radiation (λ_1 = 256 nm) at 25 ^{0}Cthrough UV radiation (front side).

Figure 282: Paper banknote; One dollar (1U$) after coating by 3rd layer of 1% of carboxymethyl cellulose (CMC) under UV radiation (λ_1 = 256 nm) at 25 ^{0}Cthrough UV radiation (back side).

Figure 283: Paper banknote; One dollar (1U$) after coating by 3rd layer of 1% of carboxymethyl cellulose (CMC) under UV radiation (λ_2 = 336 nm) at 25 ^{0}Cthrough UV radiation (front side).

Figure 284: Paper banknote; One dollar (1U$) after coating by 3rd layer of 1% of carboxymethyl cellulose (CMC) under UV radiation (λ_2 = 336 nm) at 25 ^{0}C through UV radiation (back side).

Figure 285: Paper banknote; One riyal (1 SAR) before treatment through UV radiation (front side).

Figure 286: Paper banknote; One riyal (1 SAR) before treatment through UV radiation (back side).

Figure 287: Paper banknote; One riyal (1 SAR) before treatment after thermal ageing at 140 ^{0}C through UV radiation (front side).

Figure 288: Paper banknote; One riyal (1 SAR) before treatment after thermal ageing at 140 ^{0}C through UV radiation (back side).

Figure 289: Paper banknote; One riyal (1 SAR) before treatment under UV radiation (λ_1 = 256 nm) at 25 ^{0}C through UV radiation (front side)

Figure 290: Paper banknote; One riyal (1 SAR) before treatment under UV radiation (λ_1 = 256 nm) at 25 ^{0}C through UV radiation (back side)

Figure 291: Paper banknote; One riyal (1 SAR) before treatment under UV radiation (λ_2 = 336 nm) at 25 ^{0}Cthrough UV radiation (front side).

Figure 292: Paper banknote; One riyal (1 SAR) before treatment under UV radiation (λ_2 = 336 nm) at 25 ^{0}Cthrough UV radiation (back side).

Figure 293: Paper banknote; One riyal (1 SAR) after coating by 3rd layer of 1% of carboxymethyl cellulose (CMC) through UV radiation (front side)

Figure 294: Paper banknote; One riyal (1 SAR) after coating by 3rd layer of 1% of carboxymethyl cellulose (CMC) through UV radiation (back side).

Figure 295: Paper banknote; One riyal (1 SAR) after coating by 3rd layer of 1% of carboxymethyl cellulose (CMC) after thermal ageing at 140 ^{0}C through UV radiation (front side).

Figure 296: Paper banknote; One riyal (1 SAR) after coating by 3rd layer of 1% of carboxymethyl cellulose (CMC) after thermal ageing at 140 ^{0}C through UV radiation (back side).

Figure 297: Paper banknote; One riyal (1 SAR) after coating by 3rd layer of 1% of carboxymethyl cellulose (CMC) under UV radiation (λ_1 = 256 nm) at 25 ^{0}Cthrough UV radiation (front side).

Figure (298): Paper banknote; One riyal (1 SAR) after coating by 3rd layer of 1% of carboxymethyl cellulose (CMC) under UV radiation (λ_1 = 256 nm) at 25 ^{0}Cthrough UV radiation (back side).

Figure (299): Paper banknote; One riyal (1 SAR) after coating by 3rd layer of 1% of carboxymethyl cellulose (CMC) under UV radiation (λ_2 = 336 nm) at 25 ^{0}Cthrough UV radiation (front side).

Figure 300: Paper banknote; One riyal (1 SAR) after coating by 3rd layer of 1% of carboxymethyl cellulose (CMC) under UV radiation (λ_2 = 336 nm) at 25 ^{0}Cthrough UV radiation (front side).

Figure 301: Paper banknote; 5 Dirham "AED", before treatment through UV radiation (front side).

Figure 302: Paper banknote; 5 Dirham "AED"before treatment through UV radiation (back side).

Figure 303: Paper banknote; 5 Dirham "AED"before treatment after thermal ageing at 140 ^{0}C through UV radiation (front side).

Figure 304: Paper banknote; 5 Dirham "AED"before treatment after thermal ageing at 140 ^{0}C through UV radiation (back side).

Figure 305: Paper banknote; 5 Dirham "AED" before treatment under UV radiation (λ_1 = 256 nm) at 25 ^{0}C through UV radiation (front side).

Figure 306: Paper banknote; 5 Dirham "AED" before treatment under UV radiation (λ_1 = 256 nm) at 25 ^{0}C through UV radiation (back side).

Figure 307: Paper banknote; 5 Dirham "AED" before treatment under UV radiation (λ_2 = 336 nm) at 25 ^{0}Cthrough UV radiation (front side).

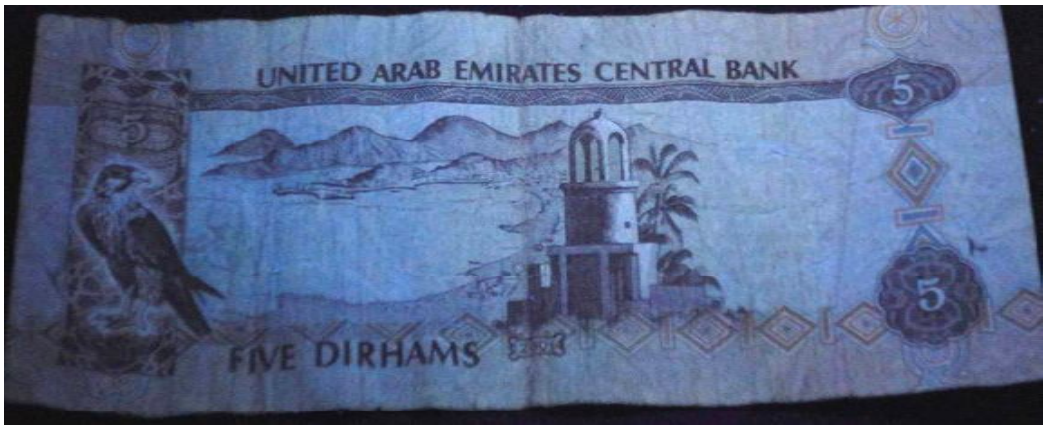

Figure 308: Paper banknote; 5 Dirham "AED" before treatment under UV radiation (λ_2 = 336 nm) at 25 ^{0}C through UV radiation (back side).

Figure 309: Paper banknote; 5 Dirham "AED" after coating by 3rd layer of 1% of carboxymethyl cellulose (CMC) through UV radiation (front side).

Figure 310: Paper banknote; 5 Dirham "AED" after coating by 3rd layer of 1% of carboxymethyl cellulose (CMC) through UV radiation (back side).

Figure 311: Paper banknote; 5 Dirham "AED" after coating by 3rd layer of 1% of carboxymethyl cellulose (CMC) after thermal ageing at 140 ^{0}C through UV radiation (front side).

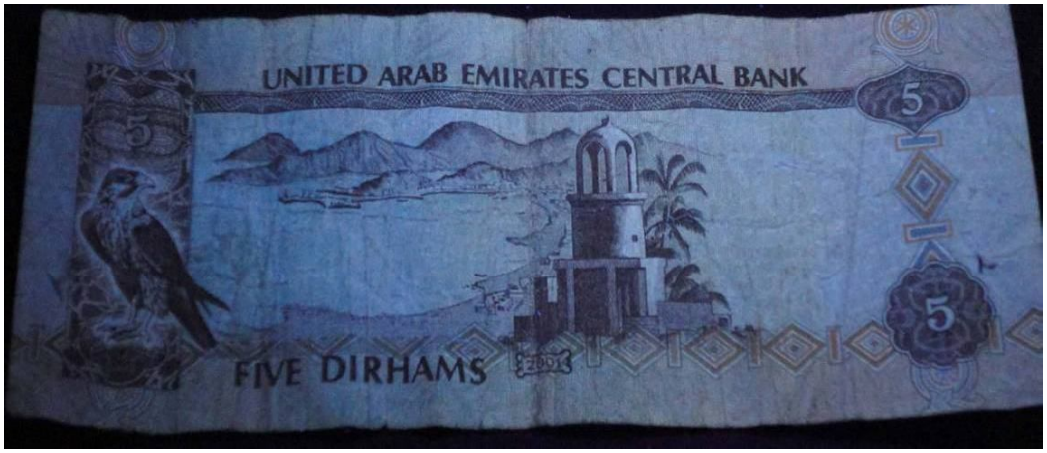

Figure 312: Paper banknote; 5 Dirham "AED" after coating by 3rd layer of 1% of carboxymethyl cellulose (CMC) after thermal ageing at 140 ^{0}C through UV radiation (back side).

Figure (313): Paper banknote; 5 Dirham "AED" after coating by 3rd layer of 1% of carboxymethyl cellulose (CMC) under UV radiation (λ_1 = 256 nm) at 25 ^{0}Cthrough UV radiation (front side).

Figure 314: Paper banknote; 5 Dirham "AED" after coating by 3rd layer of 1% of carboxymethyl cellulose (CMC) under UV radiation (λ_1 = 256 nm) at 25 ^{0}Cthrough UV radiation (back side).

Figure 315: Paper banknote; 5 Dirham "AED" after coating by 3rd layer of 1% of carboxymethyl cellulose (CMC) under UV radiation (λ_2 = 336 nm) at 25 ^{0}Cthrough UV radiation (front side).

Figure 316: Paper banknote; 5 Dirham "AED" after coating by 3rd layer of 1% of carboxymethyl cellulose (CMC) under UV radiation (λ_2 = 336 nm) at 25 ^{0}C through UV radiation (back side).

Figure 317: Paper banknote; 5 Euro "€" before treatment through UV radiation (front side).

Figure 318: Paper banknote; 5 Euro "€" before treatment through UV radiation (back side).

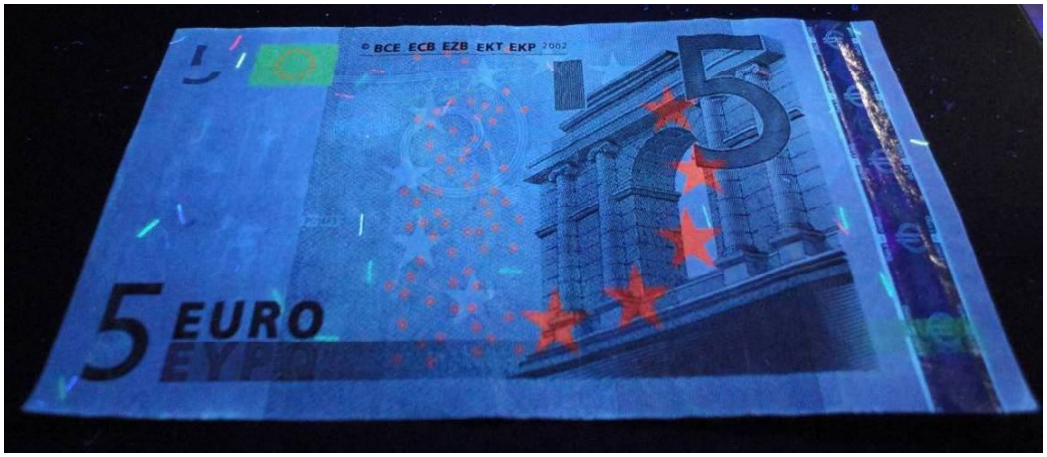

Figure 319: Paper banknote; 5 Euro "€" before treatment after thermal ageing at 140 ^{0}C through UV radiation (front side).

Figure 320: Paper banknote; 5 Euro "€" before treatment after thermal ageing at 140 ^{0}C through UV radiation (back side)

Figure 321: Paper banknote; 5 Euro "€" before treatment under UV radiation (λ_1 = 256 nm) at 25 ^{0}C through UV radiation (front side)

Figure 322: Paper banknote; 5 Euro "€" before treatment under UV radiation (λ_1 = 256 nm) at 25 ^{0}C through UV radiation (back side).

Figure 323: Paper banknote; 5 Euro "€" before treatment under UV radiation (λ_2 = 336 nm) at 25 ^{0}Cthrough UV radiation (front side).

Figure 324: Paper banknote; 5 Euro "€" before treatment under UV radiation (λ_2 = 336 nm) at 25 ^{0}C through UV radiation (back side)

Figure 325: Paper banknote; 5 Euro "€" after coating by 3rd layer of 1% of carboxymethyl cellulose (CMC) through UV radiation (front side)

Figure 326: Paper banknote; 5 Euro "€" after coating by 3rd layer of 1% of carboxymethyl cellulose (CMC) through UV radiation (back side)

Figure (327): Paper banknote; 5 Euro "€" after coating by 3rd layer of 1% of carboxymethyl cellulose (CMC) after thermal ageing at 140 ^{0}C through UV radiation (front side)

Figure 328: Paper banknote; 5 Euro "€" after coating by 3rd layer of 1% of carboxymethyl cellulose (CMC) after thermal ageing at 140 ^{0}C through UV radiation (back side).

Figure 329: Paper banknote; 5 Euro "€" after coating by 3rd layer of 1% of carboxymethyl cellulose (CMC) under UV radiation (λ_1 = 256 nm) at 25 ^{0}Cthrough UV radiation (front side)

Figure 330: Paper banknote; 5 Euro "€" after coating by 3rd layer of 1% of carboxymethyl cellulose (CMC) under UV radiation (λ_1 = 256 nm) at 25 ^{0}Cthrough UV radiation (back side)

Figure 331: Paper banknote; 5 Euro "€" after coating by 3rd layer of 1% of carboxymethyl cellulose (CMC) under UV radiation (λ_2 = 336 nm) at 25 ^{0}Cthrough UV radiation (front side).

Figure 332: Paper banknote; 5 Euro "€" after coating by 3rd layer of 1% of carboxymethyl cellulose (CMC) under UV radiation (λ_2 = 336 nm) at 25 ^{0}Cthrough UV radiation (back side).

7.Photos of different banknote papers (Egyptian 5 pounds "EGP", Egyptian 10 pounds "EGP", 1 Riyal "SAR", 5 Dirham "AED", 1 Dollar "U$", 5 Euro "€") through IR Radiation

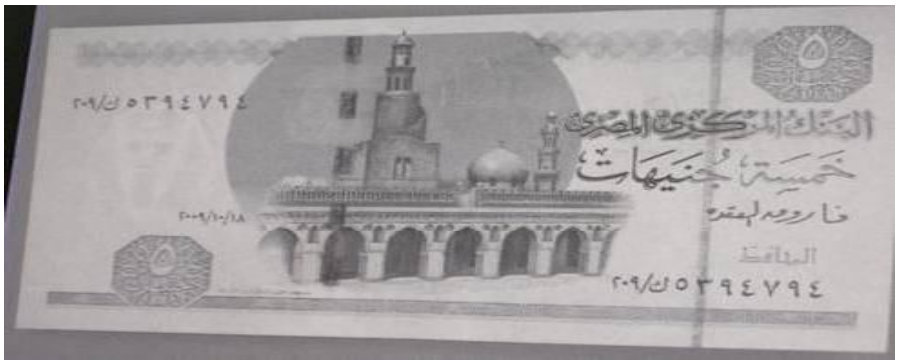

Figure 333: Paper banknote; Egyptian five pounds (5 EGP) before treatment through IR radiation (front side)

Figure 334: Paper banknote; Egyptian five pounds (5 EGP) before treatment through IR radiation (back side).

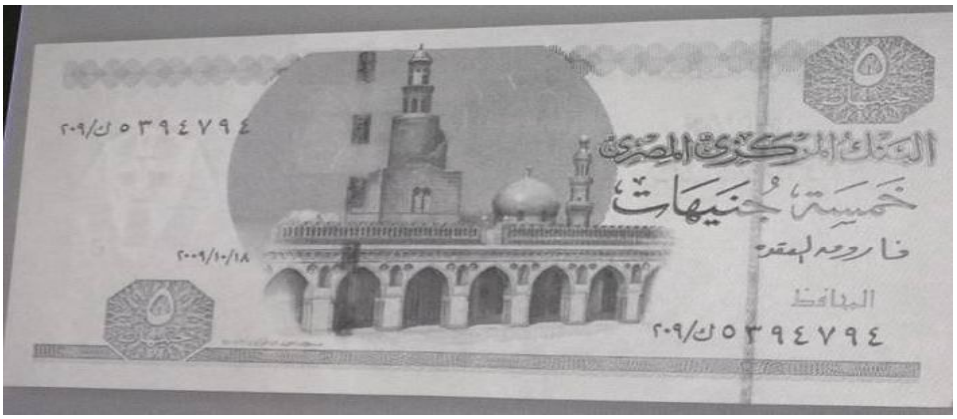

Figure 335: Paper banknote; Egyptian five pounds (5 EGP) before treatment after thermal ageing at 140 ^{0}C through IR radiation (front side).

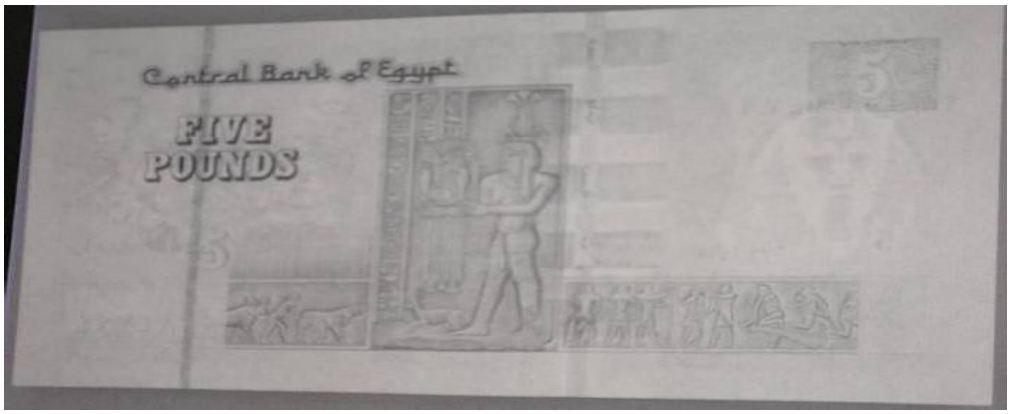

Figure 336: Paper banknote; Egyptian five pounds (5 EGP) before treatment after thermal ageing at 140 ^{0}C through IR radiation (back side).

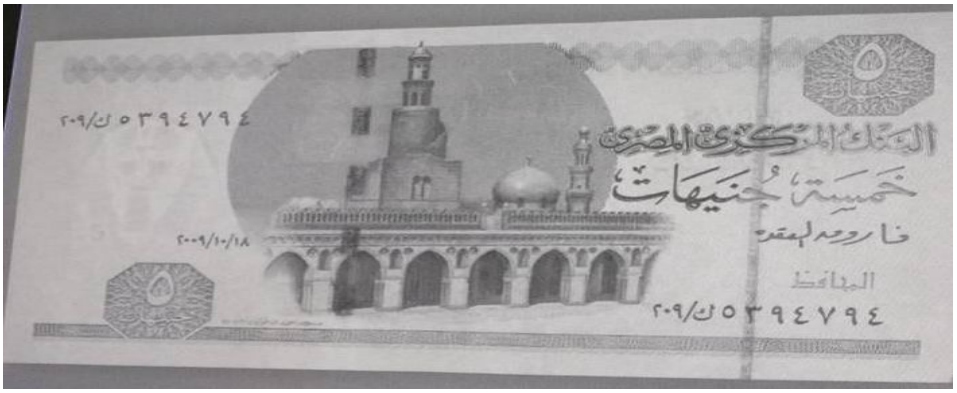

Figure 337: Paper banknote; Egyptian five pounds (5 EGP) before treatment under IR radiation (λ_1 = 256 nm) at 25 ^{0}C through IR radiation (front side).

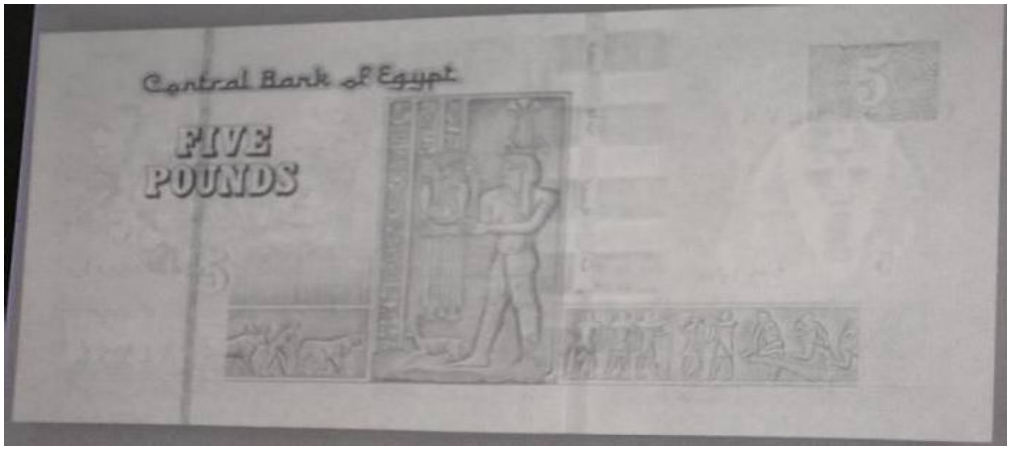

Figure 338: Paper banknote; Egyptian five pounds (5 EGP) before treatment under IR radiation (λ_1 = 256 nm) at 25 ^{0}C through IR radiation (back side)

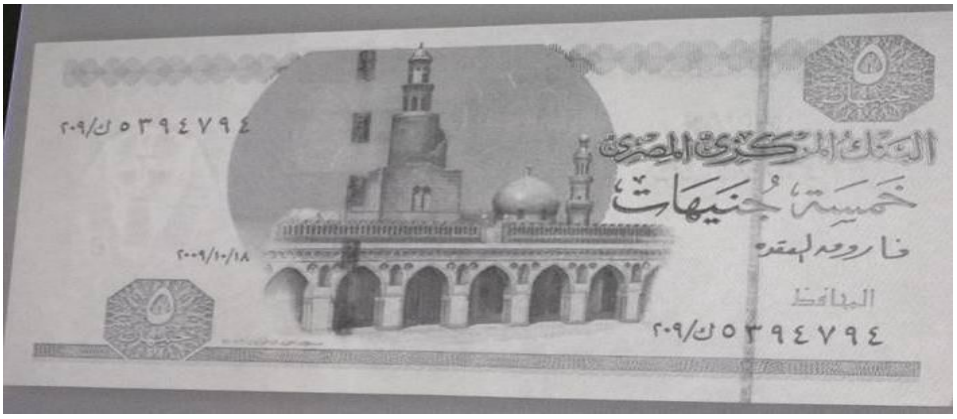

Figure 339: Paper banknote; Egyptian five pounds (5 EGP) before treatment under IR radiation (λ_2 = 336 nm) at 25 ^{0}Cthrough IR radiation (front side)

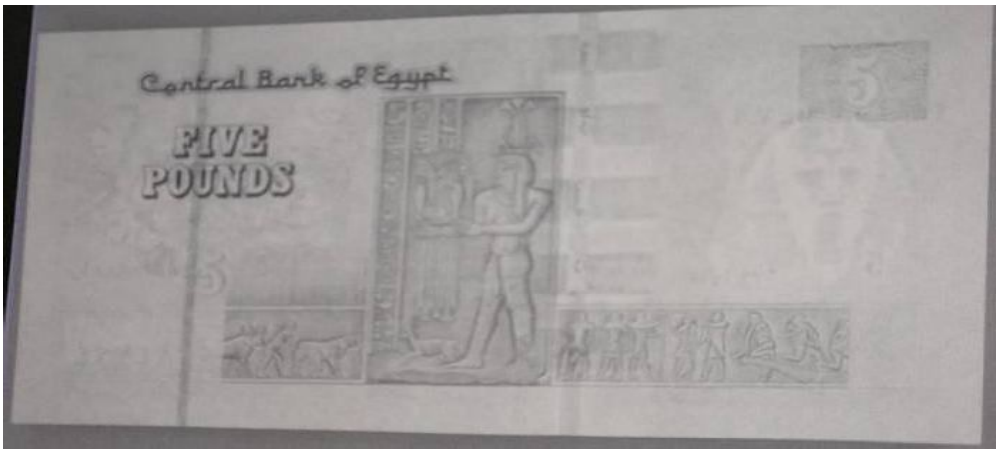

Figure 340: Paper banknote; Egyptian five pounds (5 EGP) before treatment under IR radiation (λ_2 = 336 nm) at 25 ^{0}C through IR radiation (back side).

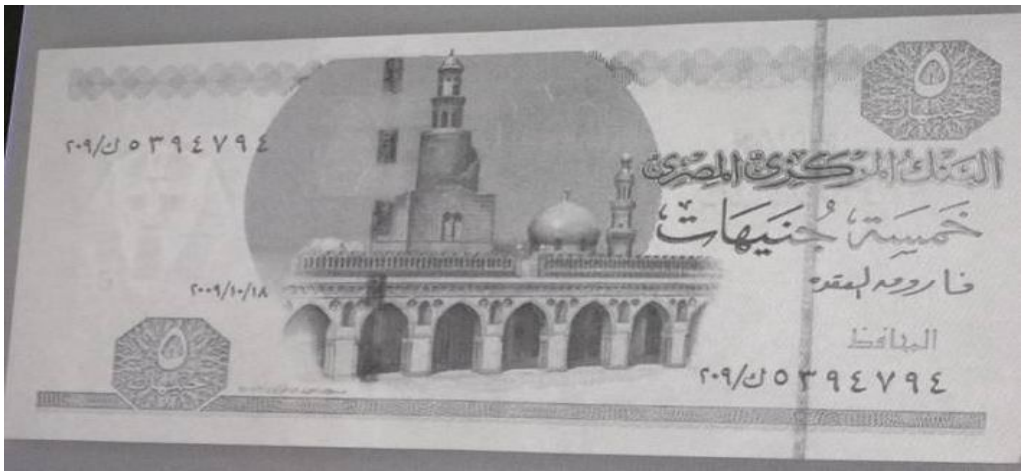

Figure 341: Paper banknote; Egyptian five pounds (5 EGP) after coating by 3rd layer of 1% of carboxymethyl cellulose (CMC) through IR radiation (front side).

Figure 342: Paper banknote; Egyptian five pounds (5 EGP) after coating by 3rd layer of 1% of carboxymethyl cellulose (CMC) through IR radiation (back side)

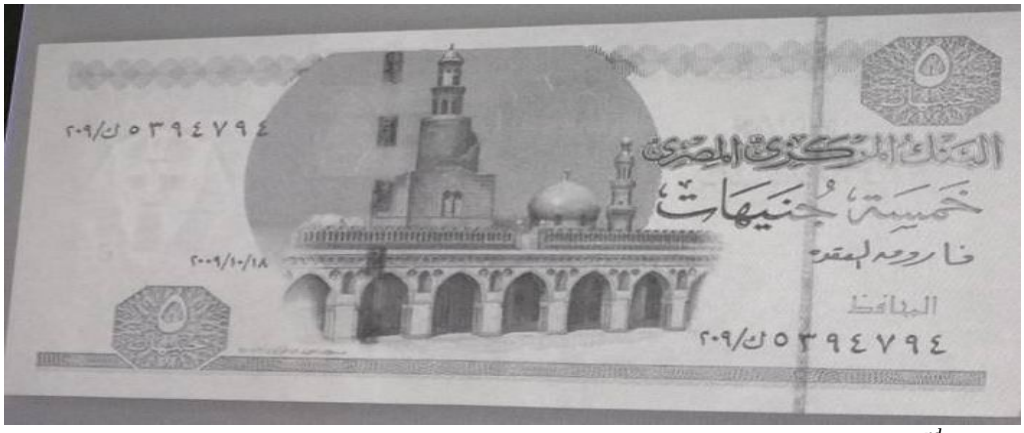

Figure 343: Paper banknote; Egyptian five pounds (5 EGP) after coating by 3rd layer of 1% of carboxymethyl cellulose (CMC) after thermal ageing at 140 ^{0}C through IR radiation (front side).

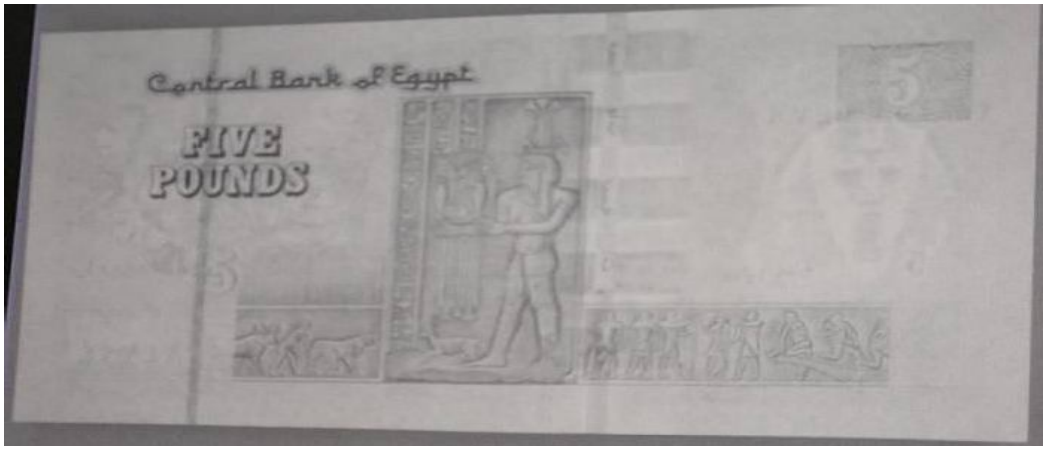

Figure 344: Paper banknote; Egyptian five pounds (5 EGP) after coating by 3rd layer of 1% of carboxymethyl cellulose (CMC) after thermal ageing at 140 ^{0}C through IR radiation (back side).

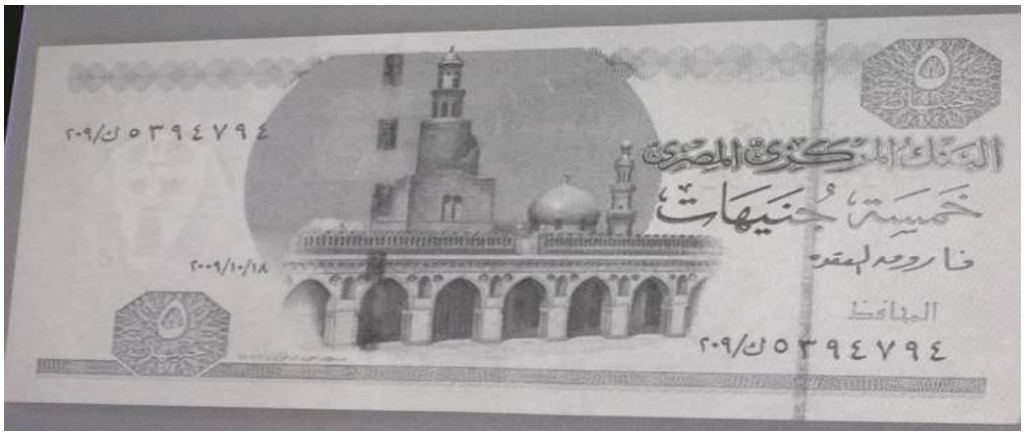

Figure 345: Paper banknote; Egyptian five pounds (5 EGP) after coating by 3rd layer of 1% of carboxymethyl cellulose (CMC) under IR radiation (λ_1 = 256 nm) at 25 ^{0}Cthrough IR radiation (front side).

Figure 346: Paper banknote; Egyptian five pounds (5 EGP) after coating by 3rd layer of 1% of carboxymethyl cellulose (CMC) under IR radiation (λ_1 = 256 nm) at 25 ^{0}Cthrough IR radiation (back side).

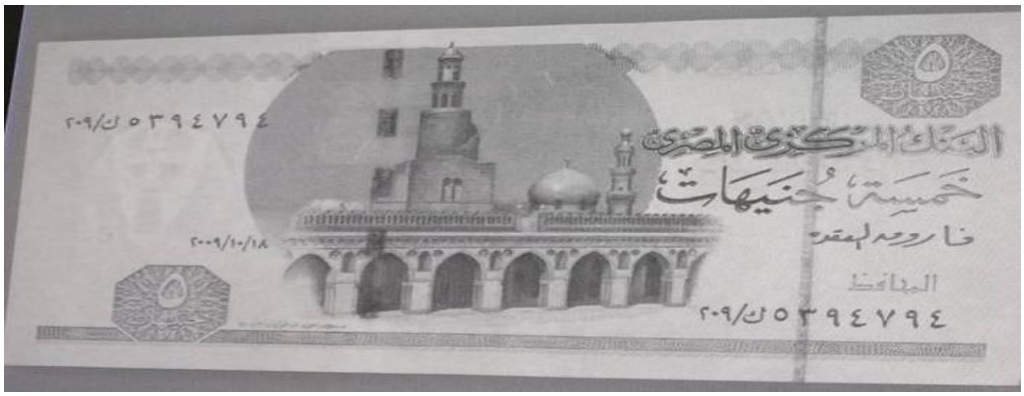

Figure (347): Paper banknote; Egyptian five pounds (5 EGP) after coating by 3rd layer of 1% of carboxymethyl cellulose (CMC) under IR radiation (λ_2 = 336 nm) at 25 ^{0}Cthrough IR radiation (front side)

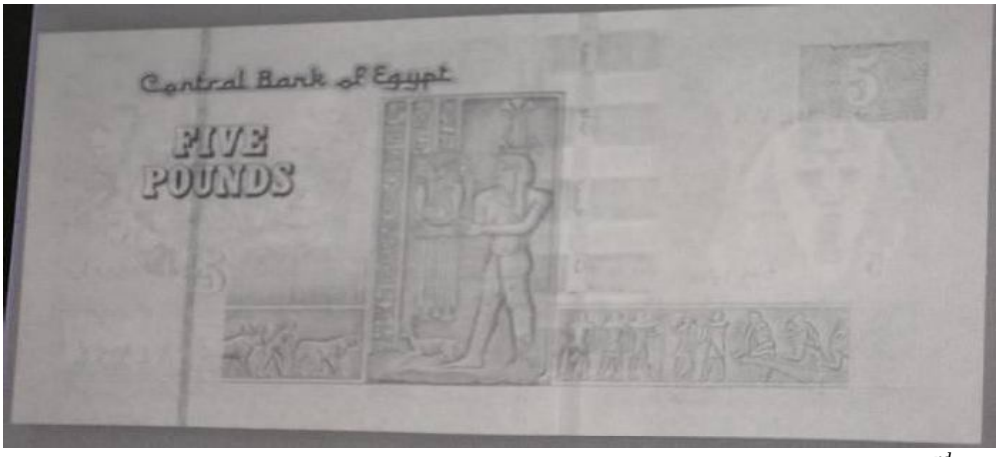

Figure (348): Paper banknote; Egyptian five pounds (5 EGP) after coating by 3rd layer of 1% of carboxymethyl cellulose (CMC) under IR radiation (λ_2 = 336 nm) at 25 ^{0}Cthrough IR radiation (back side)

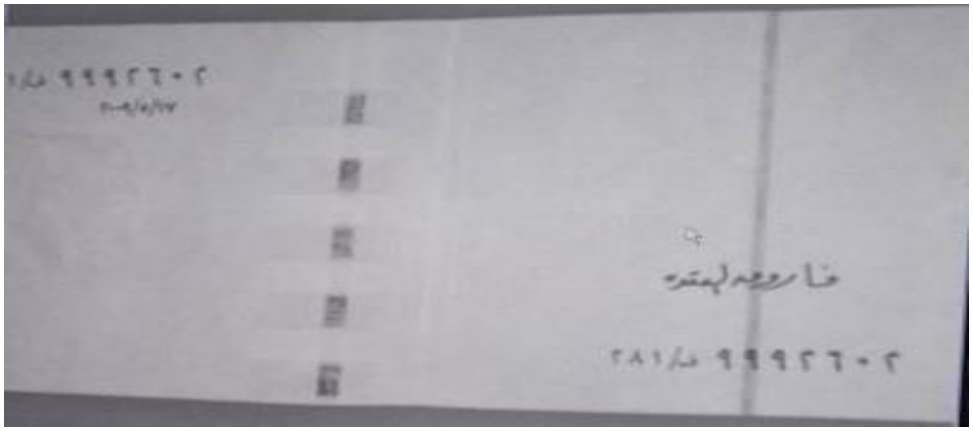

Figure 349: Paper banknote; Egyptian ten pounds (10 EGP) before treatment through IR radiation (front side).

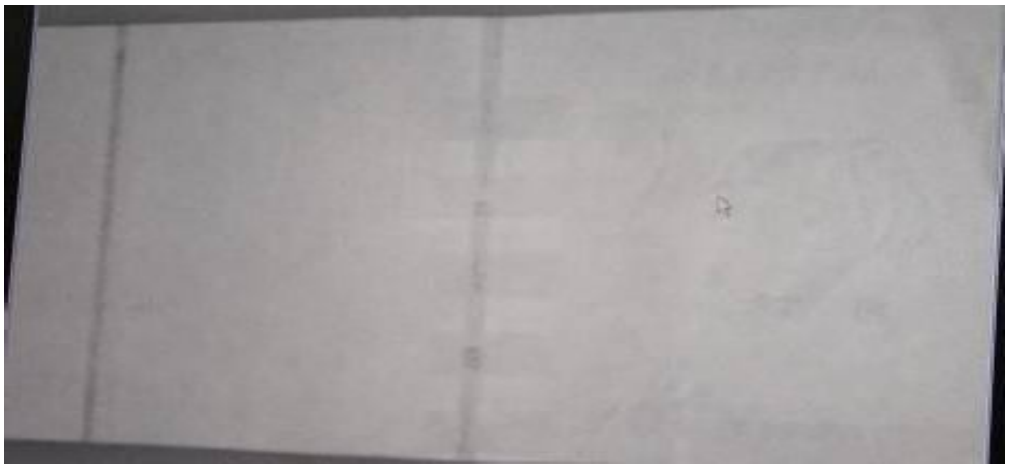

Figure 350: Paper banknote; Egyptian ten pounds (10 EGP) before treatment through IR radiation (back side)

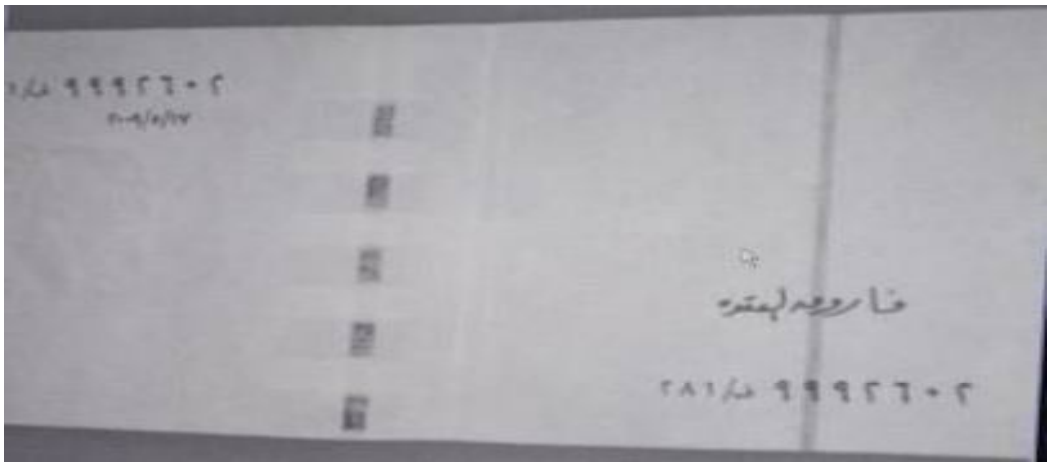

Figure 351: Paper banknote; Egyptian ten pounds (10 EGP) before treatment after thermal ageing at 140 ^{0}C through IR radiation (front side)

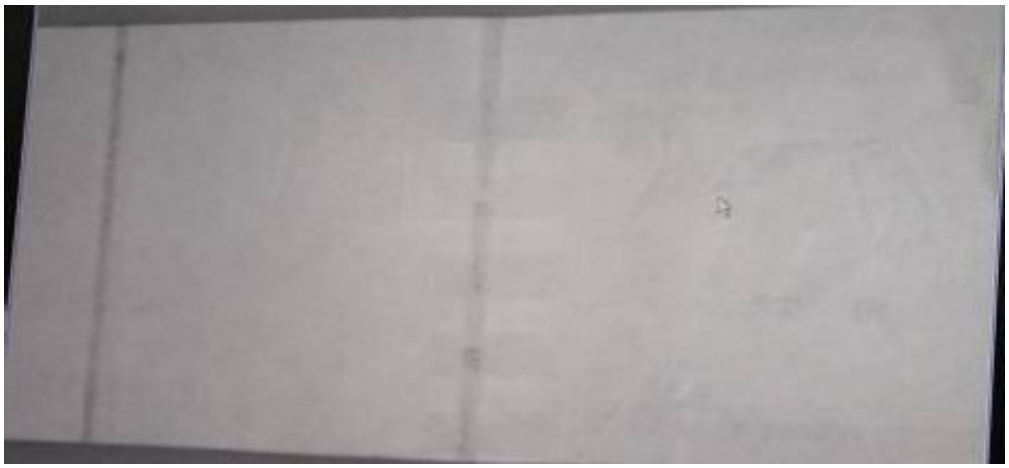

Figure 352: Paper banknote; Egyptian ten pounds (10 EGP) before treatment after thermal ageing at 140 ^{0}C through IR radiation (back side).

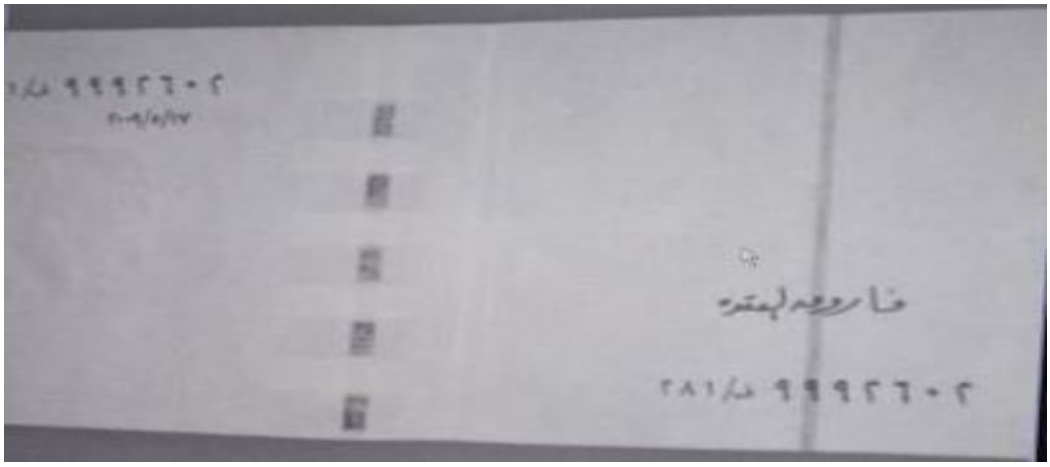

Figure 353: Paper banknote; Egyptian ten pounds (10 EGP) before treatment under IR radiation (λ_1 = 256 nm) at 25 ^{0}C through IR radiation (front side).

Figure 354: Paper banknote; Egyptian ten pounds (10 EGP) before treatment under IR radiation (λ_1 = 256 nm) at 25 ^{0}C through IR radiation (back side)

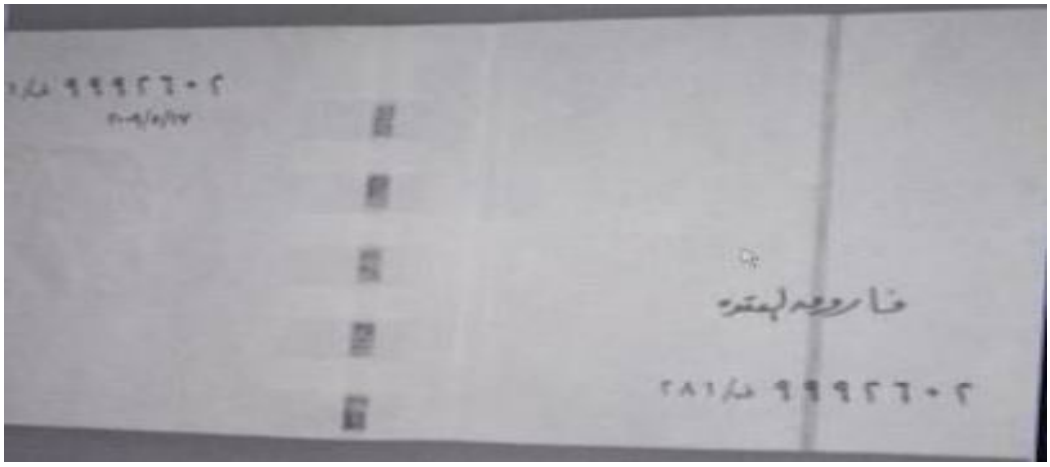

Figure 355: Paper banknote; Egyptian ten pounds (10 EGP) before treatment under IR radiation (λ_2 = 336 nm) at 25 ^{0}Cthrough IR radiation (front side)

Figure 356: Paper banknote; Egyptian ten pounds (10 EGP) before treatment under IR radiation (λ_2 = 336 nm) at 25 ^{0}Cthrough IR radiation (back side).

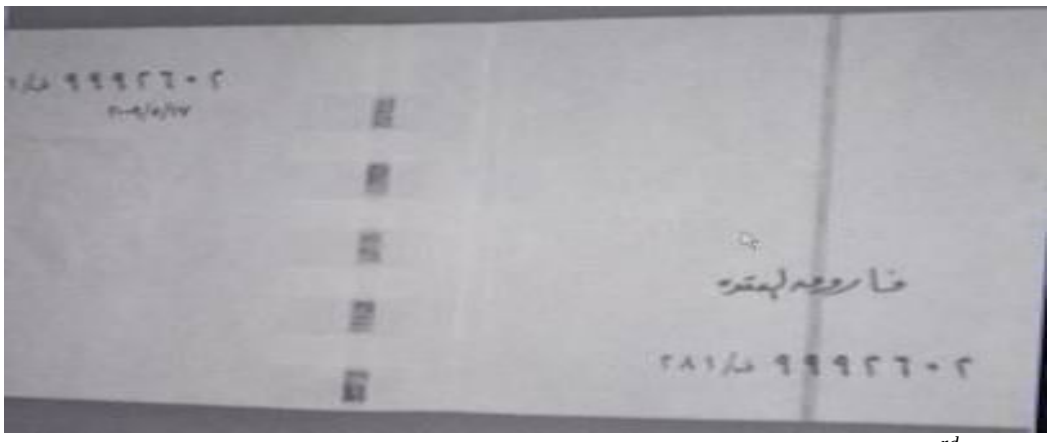

Figure 357: Paper banknote; Egyptian ten pounds (10 EGP) after coating by 3rd layer of 1% of carboxymethyl cellulose (CMC) through IR radiation (front side).

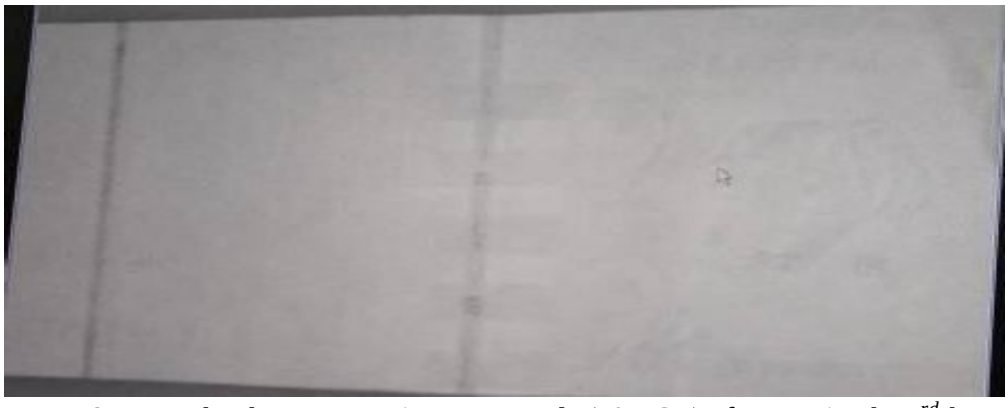

Figure 358: Paper banknote; Egyptian ten pounds (10 EGP) after coating by 3rd layer of 1% of carboxymethyl cellulose (CMC) through IR radiation (back side).

Figure 359: Paper banknote; Egyptian ten pounds (10 EGP) after coating by 3rd layer of 1% of carboxymethyl cellulose (CMC) after thermal ageing at 140 ^{0}C through IR radiation (front side)

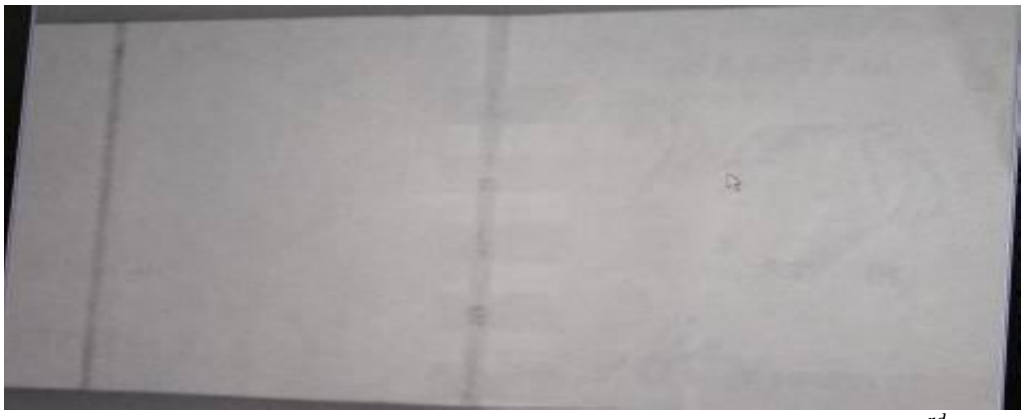

Figure 360: Paper banknote; Egyptian ten pounds (10 EGP) after coating by 3rd layer of 1% of carboxymethyl cellulose (CMC) after thermal ageing at 140 ^{0}C through IR radiation (back side)

Figure 361: Paper banknote; Egyptian ten pounds (10 EGP) after coating by 3rd layer of 1% of carboxymethyl cellulose (CMC) under IR radiation (λ_1 = 256 nm) at 25 ^{0}Cthrough IR radiation (front side)

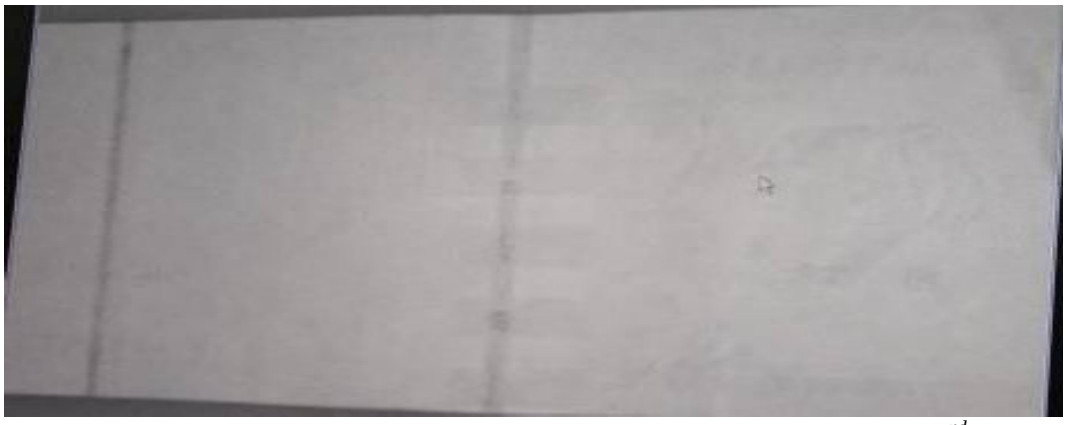

Figure 362: Paper banknote; Egyptian ten pounds (10 EGP) after coating by 3rd layer of 1% of carboxymethyl cellulose (CMC) under IR radiation (λ_1 = 256 nm) at 25 ^{0}Cthrough IR radiation (back side)

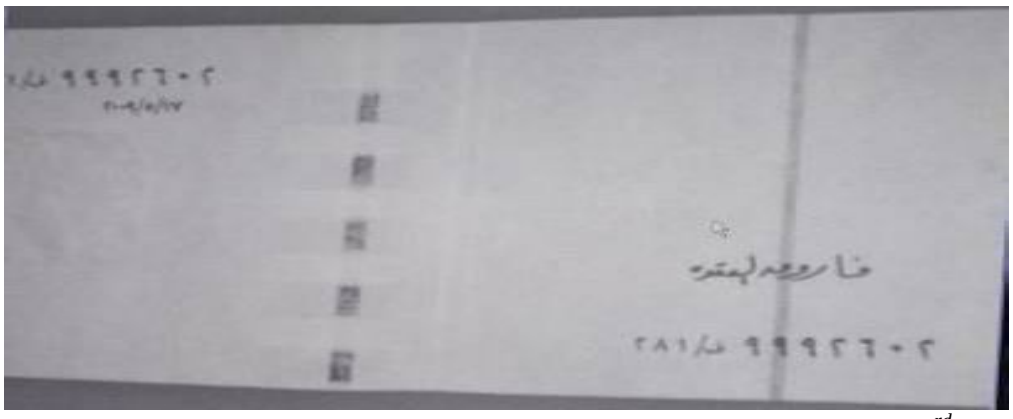

Figure 363: Paper banknote; Egyptian ten pounds (10 EGP) after coating by 3rd layer of 1% of carboxymethyl cellulose (CMC) under IR radiation (λ_2 = 336 nm) at 25 ^{0}Cthrough IR radiation (front side)

Figure 364: Paper banknote; Egyptian ten pounds (10 EGP) after coating by 3rd layer of 1% of carboxymethyl cellulose (CMC) under IR radiation (λ_2 = 336 nm) at 25 ^{0}Cthrough IR radiation (back side).

Figure 365: Paper banknote; One dollar (1U$) before treatment through IR radiation (front side).

Figure 366: Paper banknote; One dollar (1U$) before treatment through IR radiation (back side).

Figure 367: Paper banknote; One dollar (1U$) before treatment after thermal ageing at 140 ^{0}C through IR radiation (front side).

Figure 368: Paper banknote; One dollar (1U$) before treatment after thermal ageing at 140 ^{0}C through IR radiation (back side).

Figure 369: Paper banknote; One dollar (1U$) before treatment under IR radiation (λ_1 = 256 nm) at 25 ^{0}C through IR radiation (front side)

Figure 370: Paper banknote; One dollar (1U$) before treatment under IR radiation (λ_1 = 256 nm) at 25 ^{0}C through IR radiation (back side).

Figure 371: Paper banknote; One dollar (1U$) before treatment under IR radiation (λ_2 = 336 nm) at 25 ^{0}Cthrough IR radiation (front side).

Figure 372: Paper banknote; One dollar (1U$) before treatment under IR radiation (λ_2 = 336 nm) at 25 ^{0}Cthrough IR radiation (back side).

Figure 373: Paper banknote; One dollar (1U$) after coating by 3rd layer of 1% of carboxymethyl cellulose (CMC) through IR radiation (front side).

Figure 374: Paper banknote; One dollar (1U$) after coating by 3rd layer of 1% of carboxymethyl cellulose (CMC) through IR radiation (back side).

Figure 375: Paper banknote; One dollar (1U$) after coating by 3rd layer of 1% of carboxymethyl cellulose (CMC) after thermal ageing at 140 ^{0}C through IR radiation (front side).

Figure 376: Paper banknote; One dollar (1U$) after coating by 3rd layer of 1% of carboxymethyl cellulose (CMC) after thermal ageing at 140 ^{0}C through IR radiation (back side).

Figure 377: Paper banknote; One dollar (1U$) after coating by 3rd layer of 1% of carboxymethyl cellulose (CMC) under IR radiation (λ_1 = 256 nm) at 25 ^{0}Cthrough IR radiation (front side).

Figure 378: Paper banknote; One dollar (1U$) after coating by 3rd layer of 1% of carboxymethyl cellulose (CMC) under IR radiation (λ_1 = 256 nm) at 25 ^{0}Cthrough IR radiation (back side).

Figure 379) Paper banknote; One dollar (1U$) after coating by 3rd layer of 1% of carboxymethyl cellulose (CMC) under IR radiation (λ_2 = 336 nm) at 25 ^{0}Cthrough IR radiation (front side).

Figure 380: Paper banknote; One dollar (1U$) after coating by 3rd layer of 1% of carboxymethyl cellulose (CMC) under IR radiation (λ_2 = 336 nm) at 25 ^{0}Cthrough IR radiation (back side)

Figure 381: Paper banknote; One riyal (1 SAR) before treatment through IR radiation (front side).

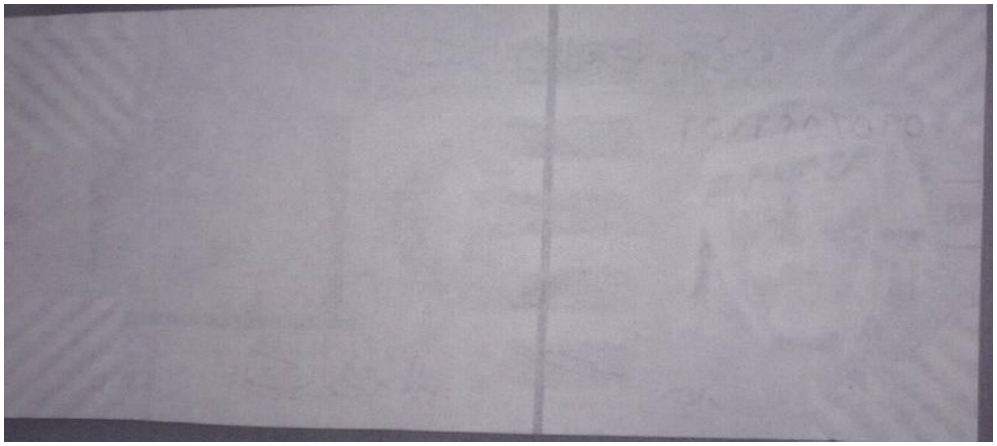

Figure (382): Paper banknote; One riyal (1 SAR) before treatment through IR radiation (back side).

Figure 383: Paper banknote; One riyal (1 SAR) before treatment after thermal ageing at 140 ^{0}C through IR radiation (front side).

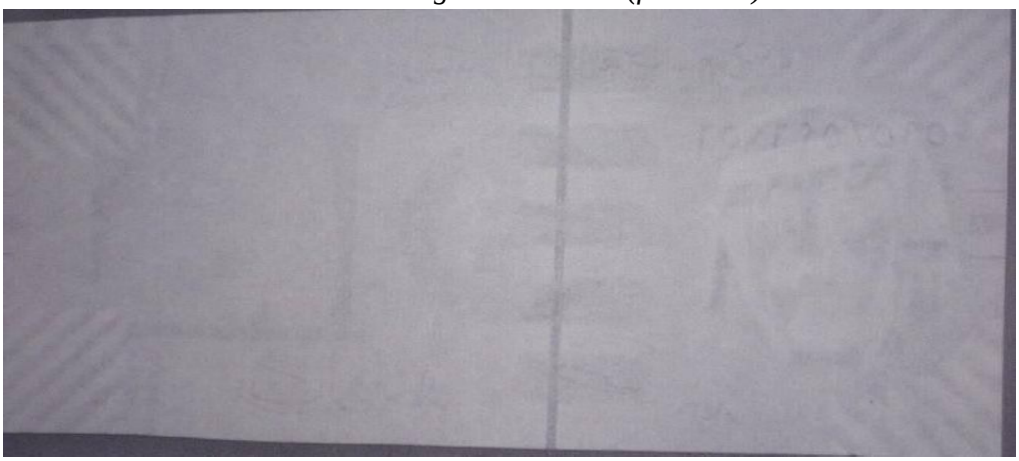

Figure 384: Paper banknote; One riyal (1 SAR) before treatment after thermal ageing at 140 ^{0}C through IR radiation (back side)

Figure 385: Paper banknote; One riyal (1 SAR) before treatment under IR radiation (λ_1 = 256 nm) at 25 ^{0}C through IR radiation (front side).

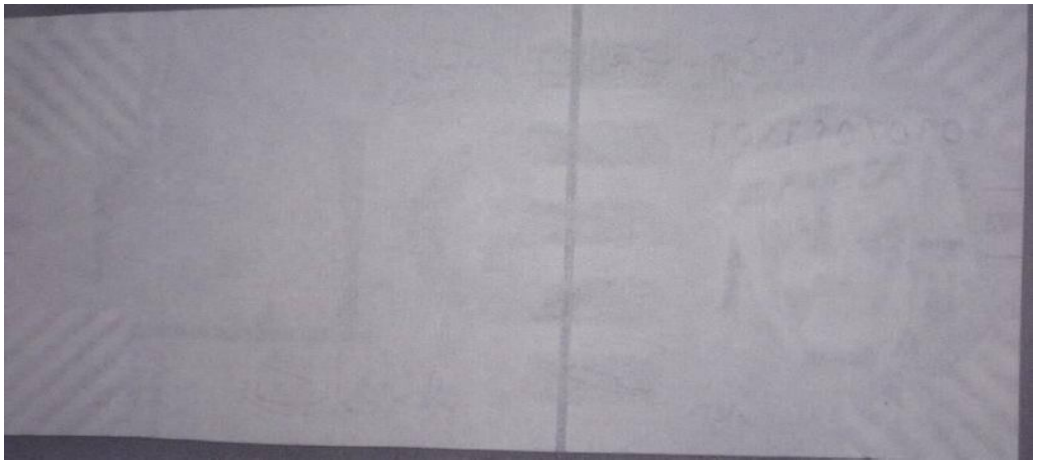

Figure 386: Paper banknote; One riyal (1 SAR) before treatment under IR radiation (λ_1 = 256 nm) at 25 ^{0}C through IR radiation (back side).

Figure 387: Paper banknote; One riyal (1 SAR) before treatment under IR radiation (λ_2 = 336 nm) at 25 ^{0}Cthrough IR radiation (front side)

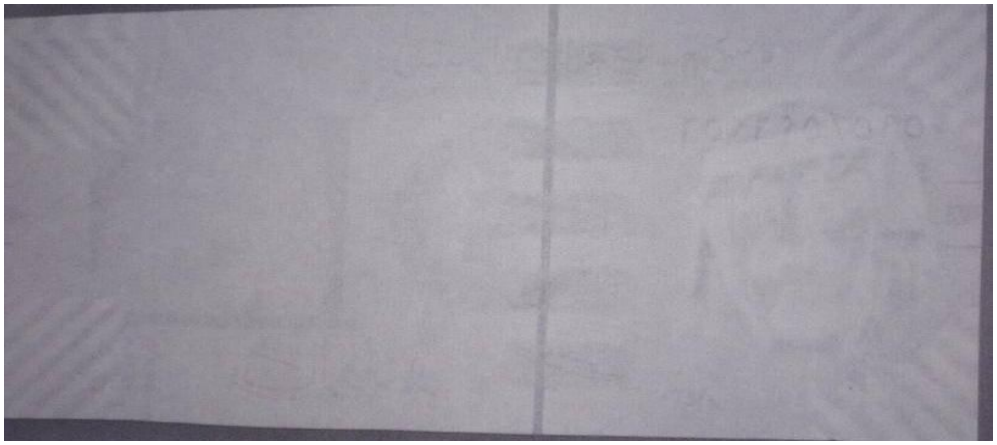

Figure 388: Paper banknote; One riyal (1 SAR) before treatment under IR radiation (λ_2 = 336 nm) at 25 ^{0}Cthrough IR radiation (back side).

Figure 389: Paper banknote; One riyal (1 SAR) after coating by 3rd layer of 1% of carboxymethyl cellulose (CMC) through IR radiation (front side).

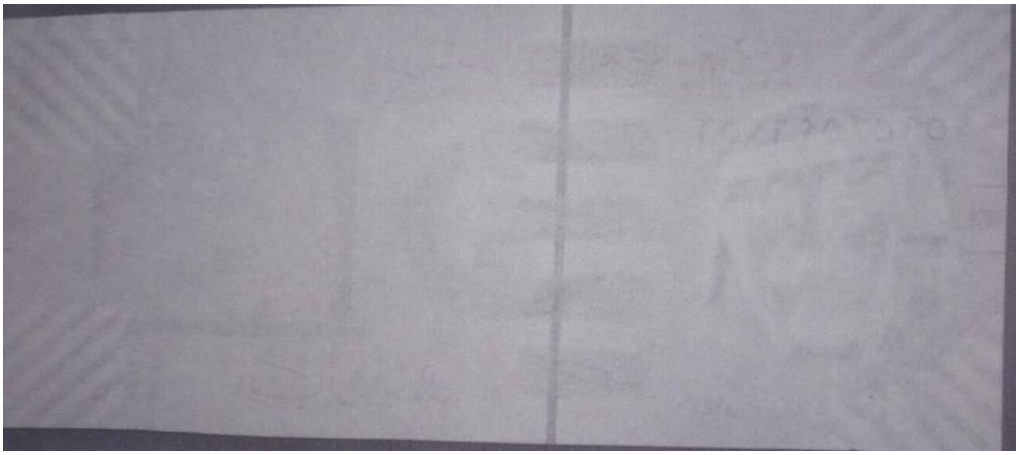

Figure 390: Paper banknote; One riyal (1 SAR) after coating by 3rd layer of 1% of carboxymethyl cellulose (CMC) through IR radiation (back side).

Figure 391: Paper banknote; One riyal (1 SAR) after coating by 3rd layer of 1% of carboxymethyl cellulose (CMC) after thermal ageing at 140 ^{0}C through IR radiation (front side).

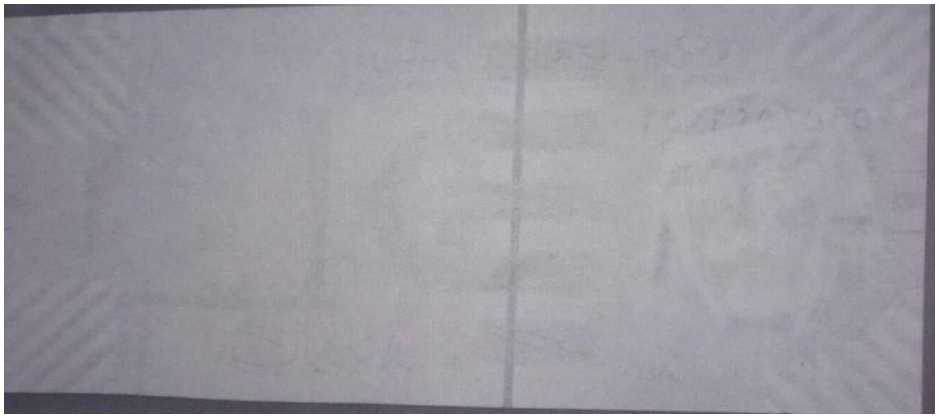

Figure 392: Paper banknote; One riyal (1 SAR) after coating by 3rd layer of 1% of carboxymethyl cellulose (CMC) after thermal ageing at 140 ^{0}C through IR radiation (back side).

Figure 393: Paper banknote; One riyal (1 SAR) after coating by 3rd layer of 1% of carboxymethyl cellulose (CMC) under IR radiation (λ_1 = 256 nm) at 25 ^{0}Cthrough IR radiation (front side).

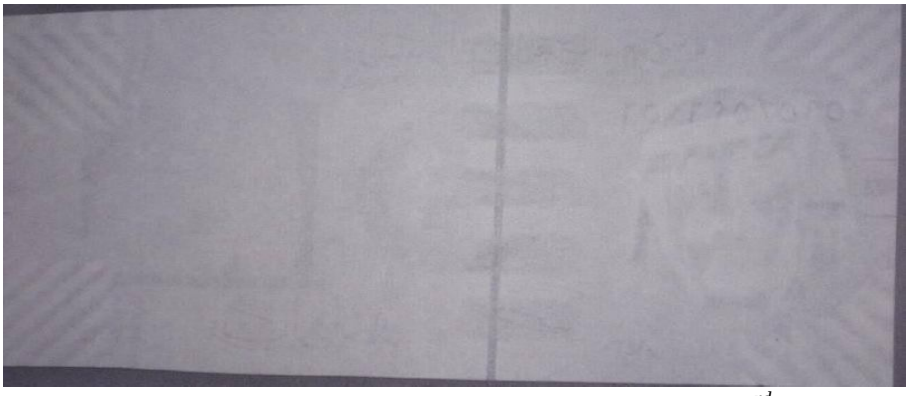

Figure 394: Paper banknote; One riyal (1 SAR) after coating by 3rd layer of 1% of carboxymethyl cellulose (CMC) under IR radiation (λ_1 = 256 nm) at 25 ^{0}Cthrough IR radiation (back side).

Figure 395: Paper banknote; One riyal (1 SAR) after coating by 3rd layer of 1% of carboxymethyl cellulose (CMC) under IR radiation (λ_2 = 336 nm) at 25 ^{0}Cthrough IR radiation (front side).

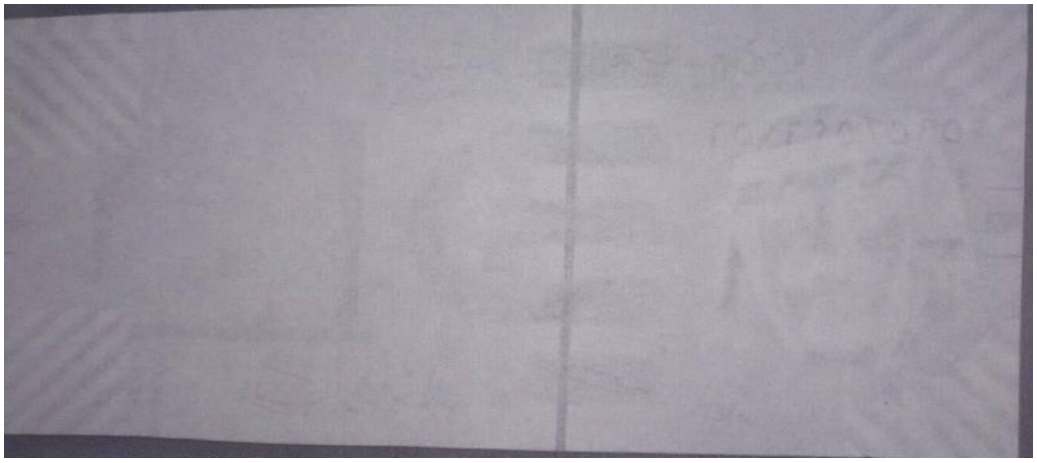

Figure 396: Paper banknote; One riyal (1 SAR) after coating by 3rd layer of 1% of carboxymethyl cellulose (CMC) under IR radiation (λ_2 = 336 nm) at 25 ^{0}Cthrough IR radiation (front side).

Figure 397: Paper banknote; 5 Dirham "AED", before treatment through IR radiation (front side).

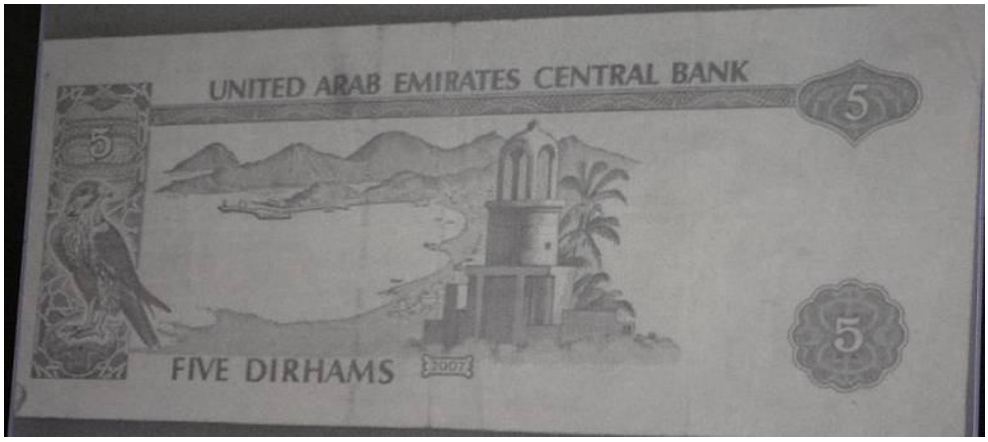

Figure 398: Paper banknote; 5 Dirham "AED"before treatment through IR radiation (back side).

Figure 399: Paper banknote; 5 Dirham "AED"before treatment after thermal ageing at 140 ^{0}C through IR radiation (front side).

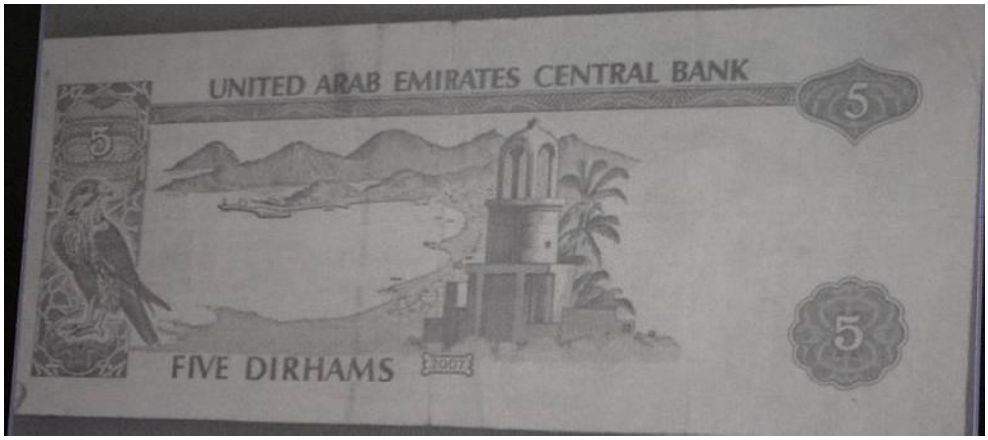

Figure 400: Paper banknote; 5 Dirham "AED"before treatment after thermal ageing at 140 ^{0}C through IR radiation (back side).

Figure 401: Paper banknote; 5 Dirham "AED" before treatment under IR radiation (λ_1 = 256 nm) at 25 ^{0}C through IR radiation (front side).

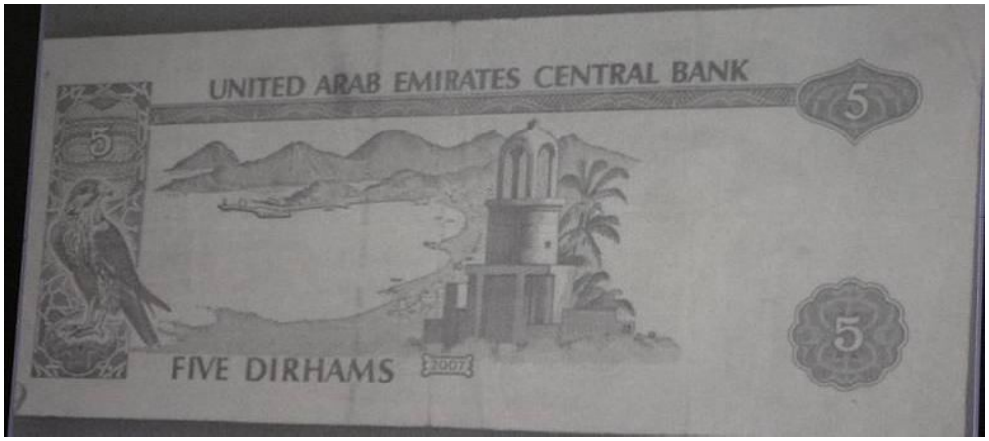

Figure 402: Paper banknote; 5 Dirham "AED" before treatment under IR radiation (λ_1 = 256 nm) at 25 ^{0}C through IR radiation (back side).

Figure 403: Paper banknote; 5 Dirham "AED" before treatment under IR radiation (λ_2 = 336 nm) at 25 ^{0}Cthrough IR radiation (front side).

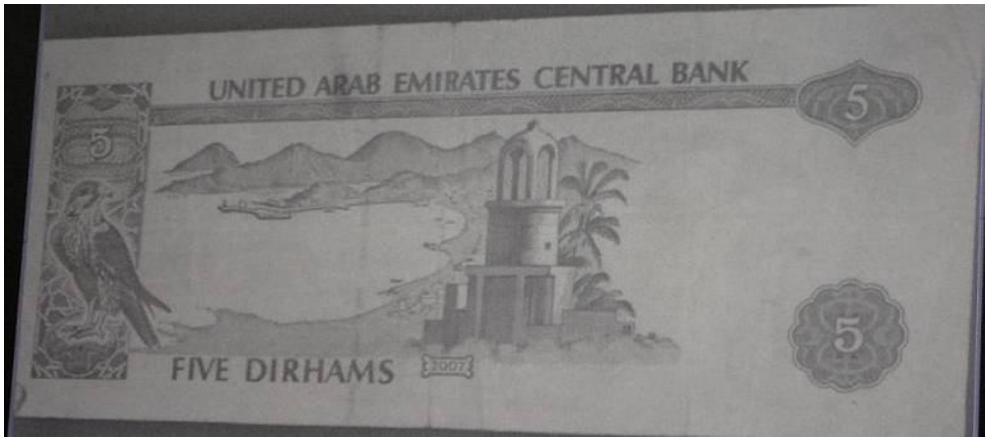

Figure 404: Paper banknote; 5 Dirham "AED" before treatment under IR radiation (λ_2 = 336 nm) at 25 ^{0}C through IR radiation (back side).

Figure 405: Paper banknote; 5 Dirham "AED" after coating by 3rd layer of 1% of carboxymethyl cellulose (CMC) through IR radiation (front side).

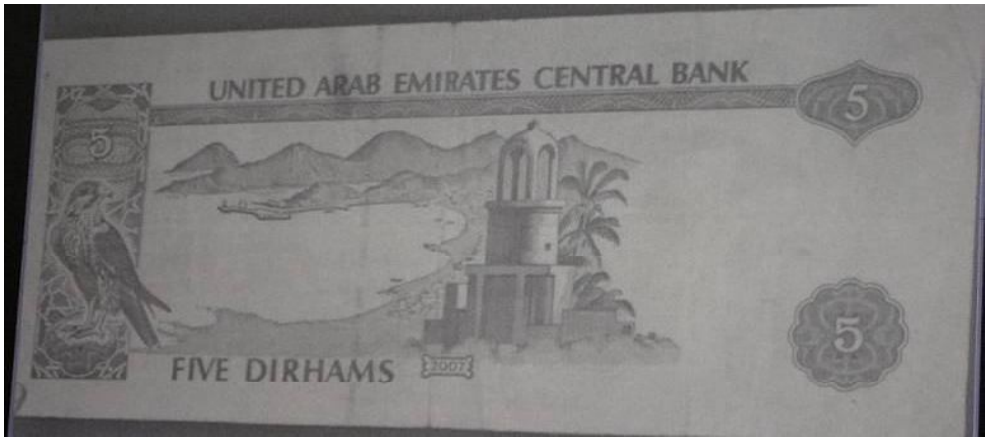

Figure (406): Paper banknote; 5 Dirham "AED" after coating by 3rd layer of 1% of carboxymethyl cellulose (CMC) through IR radiation (back side).

Figure 407: Paper banknote; 5 Dirham "AED" after coating by 3rd layer of 1% of carboxymethyl cellulose (CMC) after thermal ageing at 140 ^{0}C through IR radiation (front side).

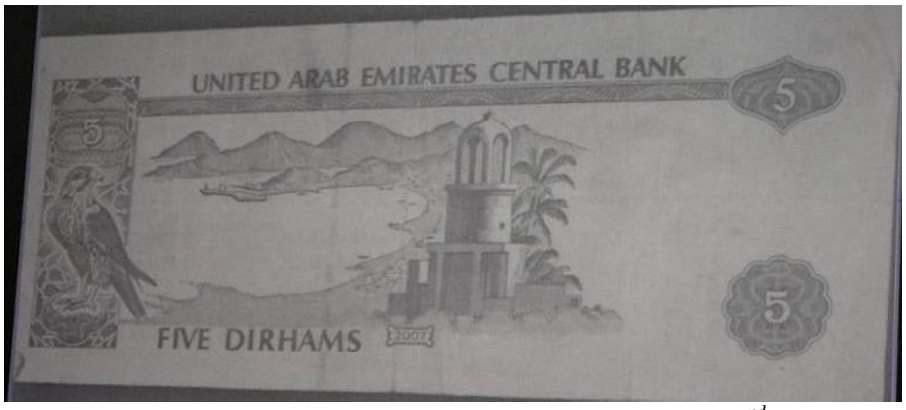

Figure 408: Paper banknote; 5 Dirham "AED" after coating by 3rd layer of 1% of carboxymethyl cellulose (CMC) after thermal ageing at 140 ^{0}C through IR radiation (back side).

Figure 409: Paper banknote; 5 Dirham "AED" after coating by 3rd layer of 1% of carboxymethyl cellulose (CMC) under IR radiation (λ_1 = 256 nm) at 25 ^{0}Cthrough IR radiation (front side).

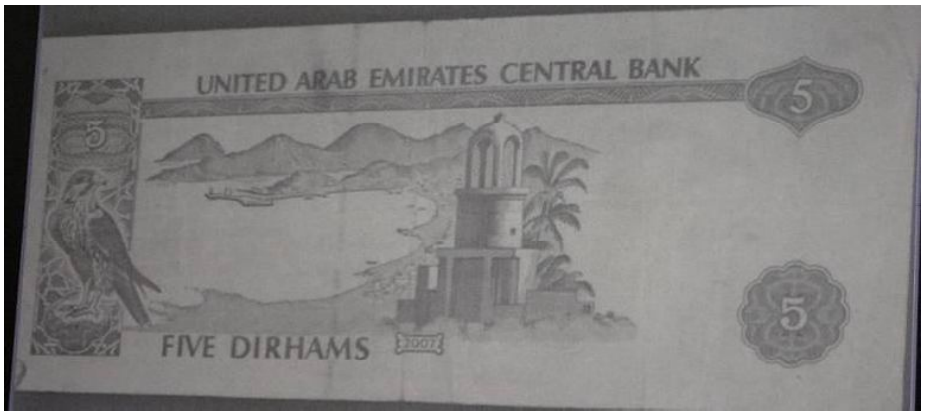

Figure 410: Paper banknote; 5 Dirham "AED" after coating by 3rd layer of 1% of carboxymethyl cellulose (CMC) under IR radiation (λ_1 = 256 nm) at 25 ^{0}Cthrough IR radiation (back side).

Figure 411: Paper banknote; 5 Dirham "AED" after coating by 3rd layer of 1% of carboxymethyl cellulose (CMC) under IR radiation (λ_2 = 336 nm) at 25 ^{0}Cthrough IR radiation (front side).

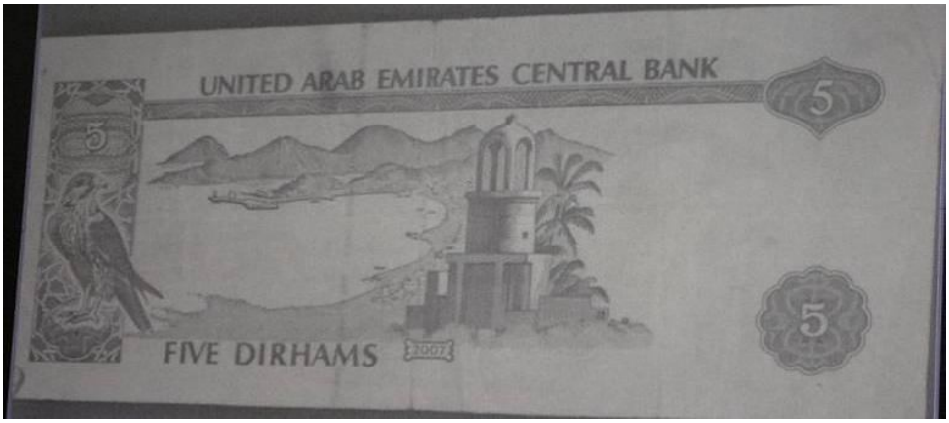

Figure 412: Paper banknote; 5 Dirham "AED" after coating by 3rd layer of 1% of carboxymethyl cellulose (CMC) under IR radiation (λ_2 = 336 nm) at 25 ^{0}Cthrough IR radiation (back side).

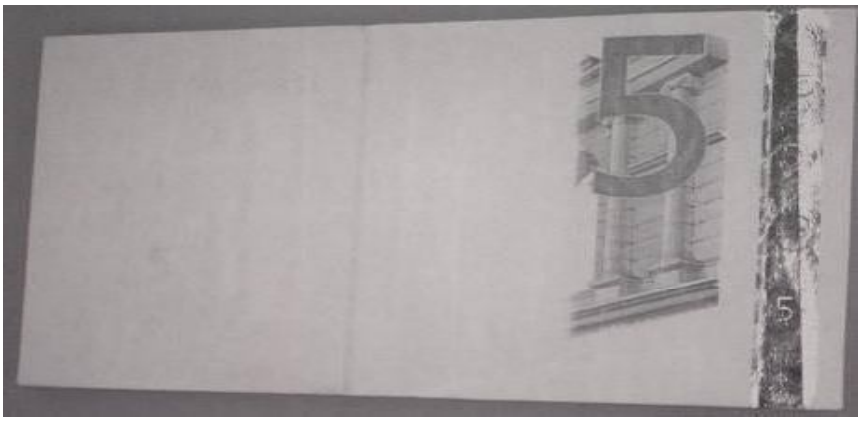

Figure 413: Paper banknote; 5 Euro "€" before treatment through IR radiation (front side).

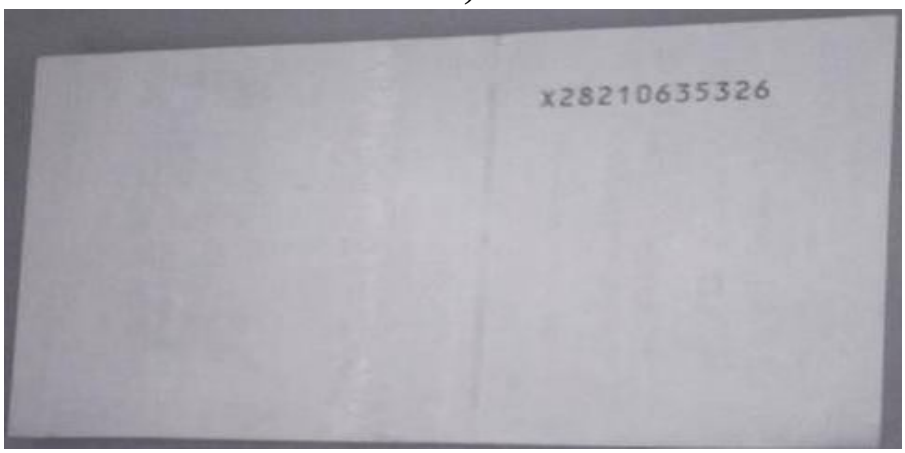

Figure 414: Paper banknote; 5 Euro "€" before treatment through IR radiation (back side)

.

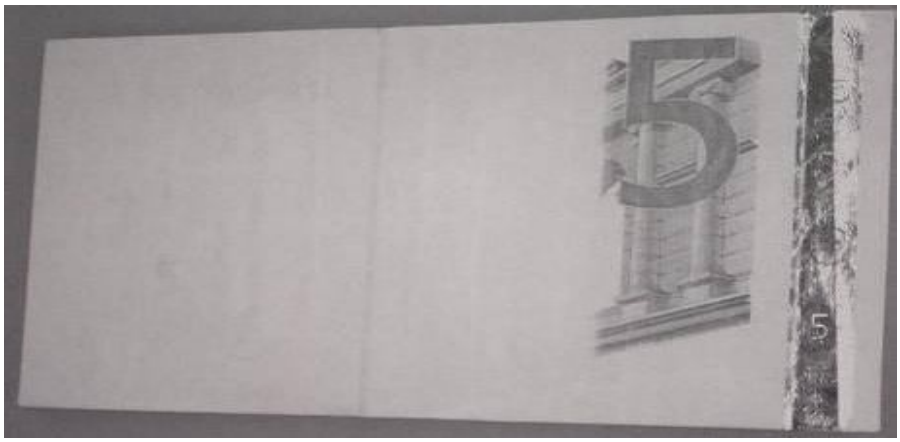

Figure 415: Paper banknote; 5 Euro "€" before treatment after thermal ageing at 140 ^{0}C through IR radiation (front side).

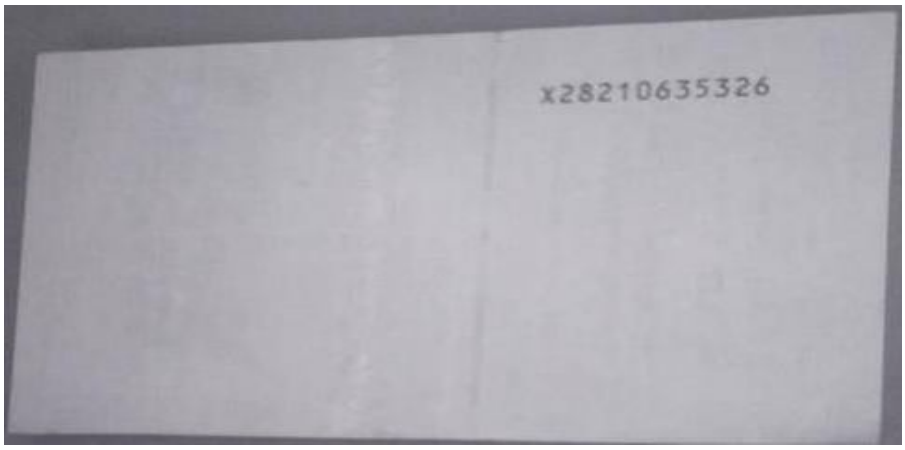

Figure 416: Paper banknote; 5 Euro "€" before treatment after thermal ageing at 140 ^{0}C through IR radiation (back side).

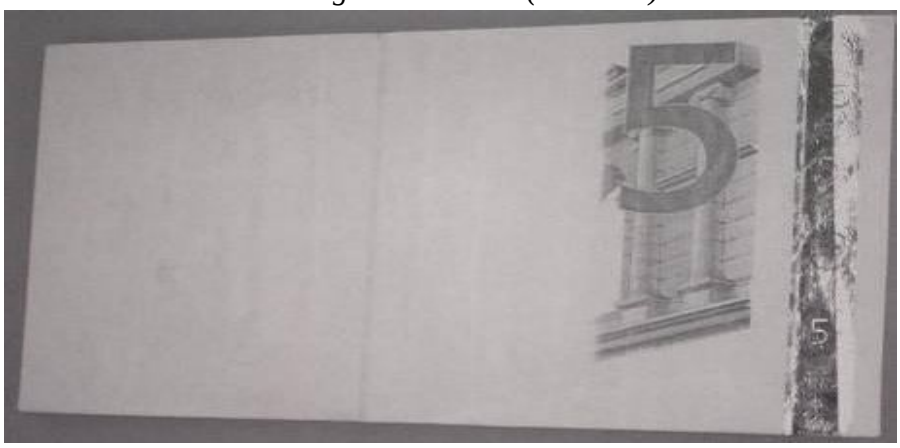

Figure 417: Paper banknote; 5 Euro "€" before treatment under IR radiation (λ_1 = 256 nm) at 25 ^{0}C through IR radiation (front side).

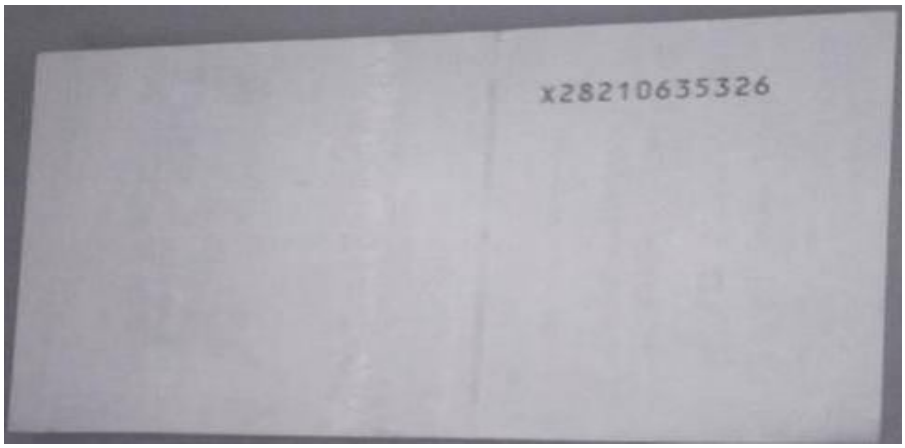

Figure 418: Paper banknote; 5 Euro "€" before treatment under IR radiation (λ_1 = 256 nm) at 25 ^{0}C through IR radiation (back side).

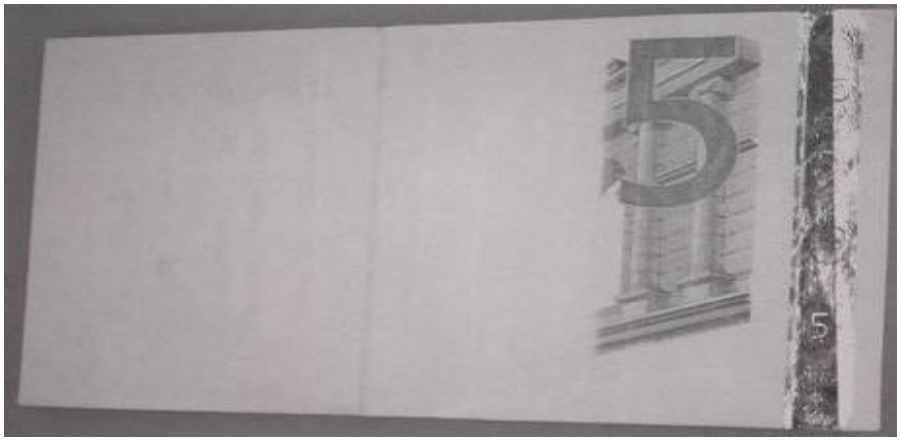

Figure 419: Paper banknote; 5 Euro "€" before treatment under IR radiation (λ_2 = 336 nm) at 25 ^{0}Cthrough IR radiation (front side).

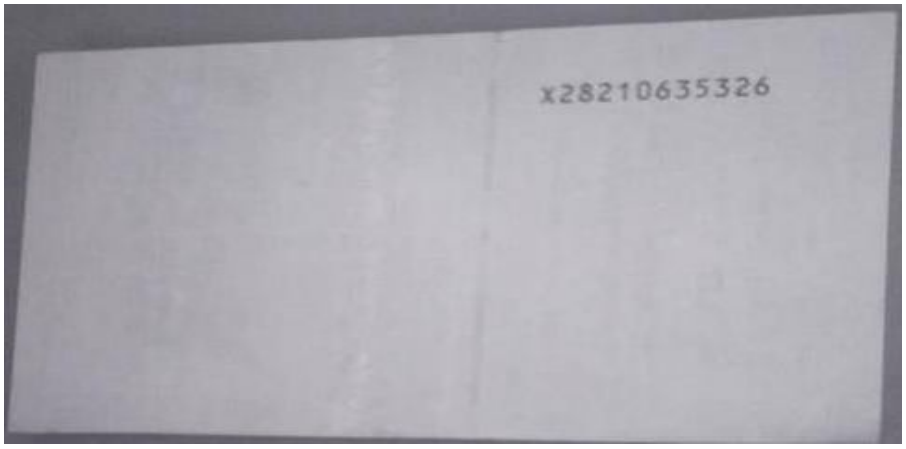

Figure 420: Paper banknote; 5 Euro "€" before treatment under IR radiation (λ_2 = 336 nm) at 25 ^{0}C through IR radiation (back side).

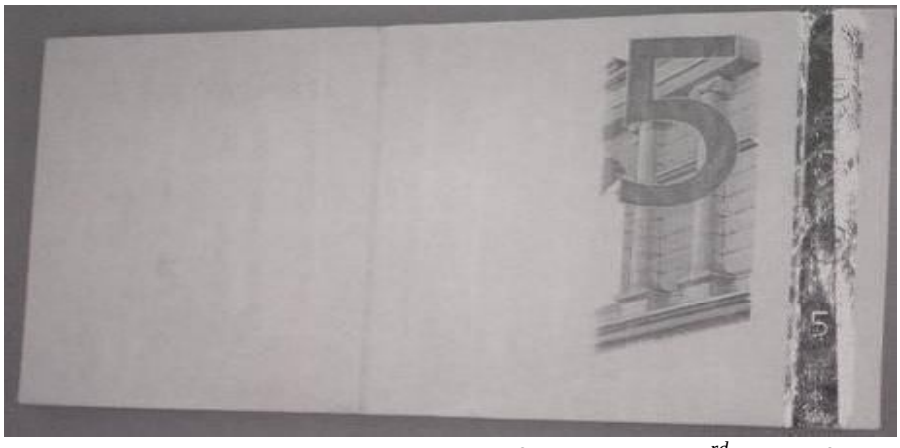

Figure 421: Paper banknote; 5 Euro "€" after coating by 3rd layer of 1% of carboxymethyl cellulose (CMC) through IR radiation (front side).

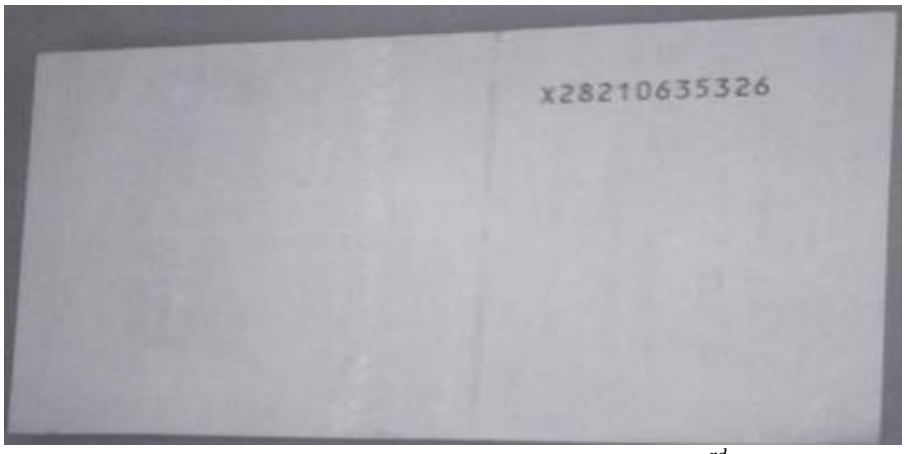

Figure 422: Paper banknote; 5 Euro "€" after coating by 3rd layer of 1% of carboxymethyl cellulose (CMC) through IR radiation (back side).

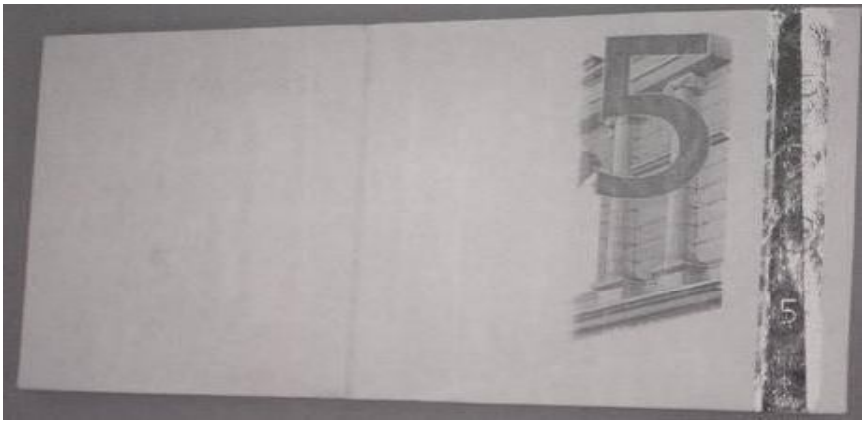

Figure 423: Paper banknote; 5 Euro "€" after coating by 3rd layer of 1% of carboxymethyl cellulose (CMC) after thermal ageing at 140 ^{0}C through IR radiation (front side).

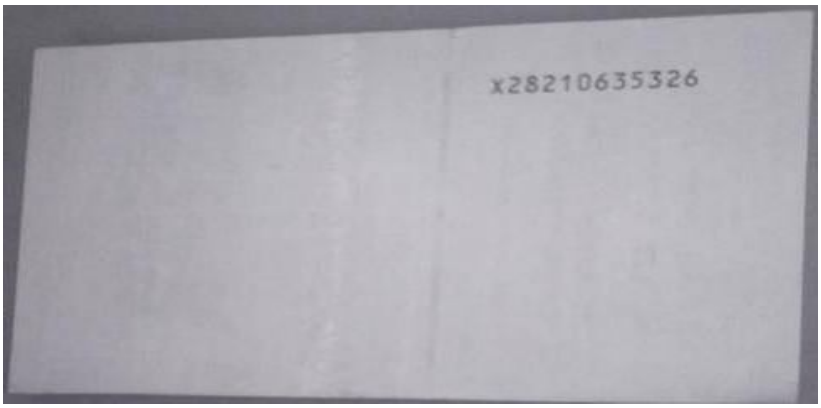

Figure 424: Paper banknote; 5 Euro "€" after coating by 3rd layer of 1% of carboxymethyl cellulose (CMC) after thermal ageing at 140 ^{0}C through IR radiation (back side).

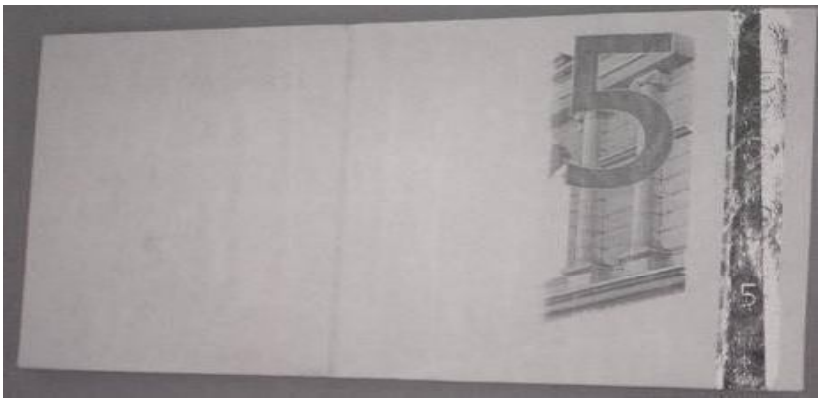

Figure 425: Paper banknote; 5 Euro "€" after coating by 3rd layer of 1% of carboxymethyl cellulose (CMC) under IR radiation (λ_1 = 256 nm) at 25 ^{0}Cthrough IR radiation (front side).

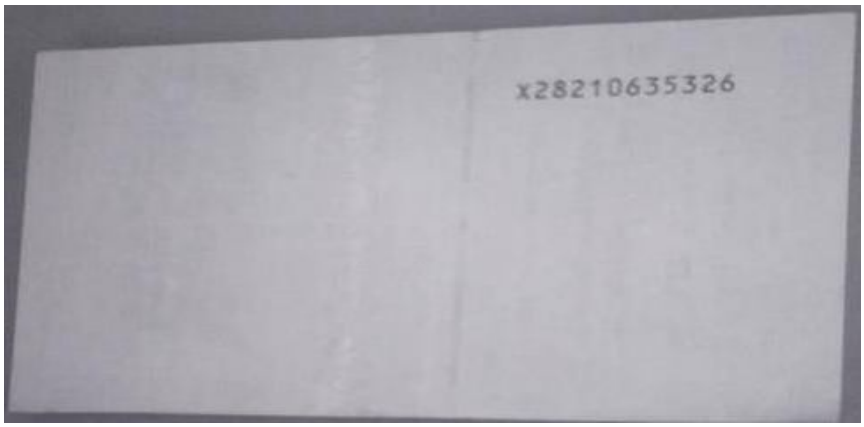

Figure 426: Paper banknote; 5 Euro "€" after coating by 3rd layer of 1% of carboxymethyl cellulose (CMC) under IR radiation (λ_1 = 256 nm) at 25 ^{0}Cthrough IR radiation (back side).

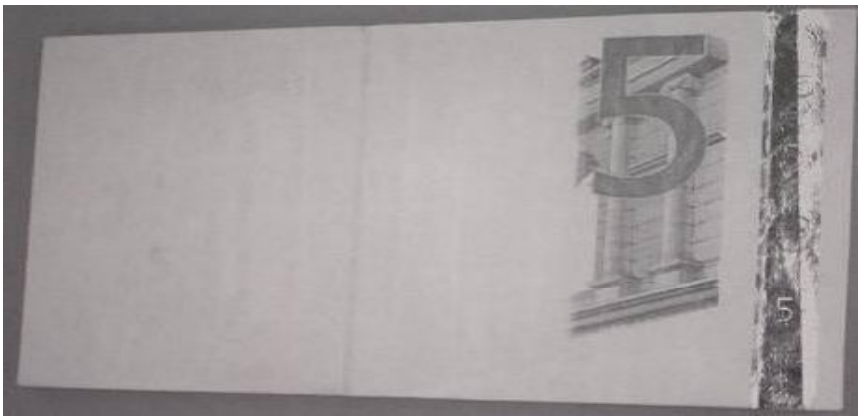

Figure 427: Paper banknote; 5 Euro "€" after coating by 3rd layer of 1% of carboxymethyl cellulose (CMC) under IR radiation (λ_2 = 336 nm) at 25 ^{0}Cthrough IR radiation (front side).

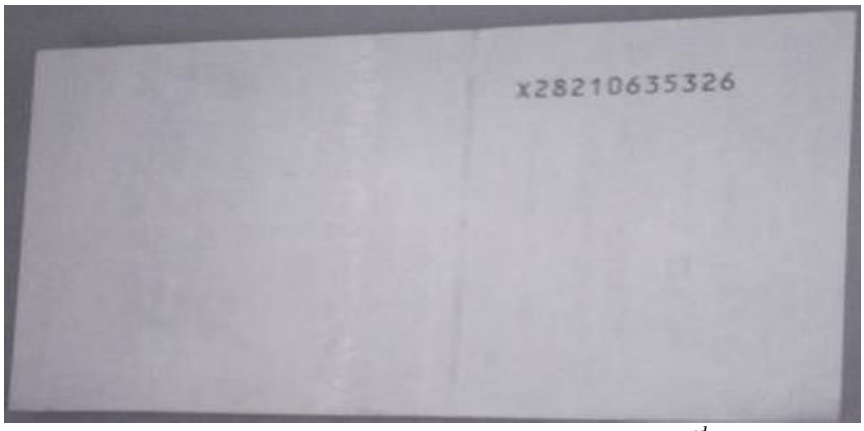

Figure 428: Paper banknote; 5 Euro "€" after coating by 3rd layer of 1% of carboxymethyl cellulose (CMC) under IR radiation (λ_2 = 336 nm) at 25 ^{0}Cthrough IR radiation (back side).

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