



## Investigation of the Effects of Dry Film Thickness and Peak Metal Temperature on Surface Effect on Polyester Wrinkle Coil Coatings

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Particle and textural structure of polyester wrinkle paints gives a special decoration on coil coated flat steel products' surfaces. However, it is difficult to achieve the same wrinkle effect continuously because of sensitivity of the texture to the fluctuations of some production parameters.

In this study, the effect of dry film thickness and peak metal temperature on color deviation and wrinkle surface texture of wrinkle polyester paint application flat steel products were investigated. In order to understand the effect of the thickness, different dry film thicknesses of RAL 3009 paint were applied on DX51-Z100 grade galvanized steel sheet by keeping the peak metal temperature constant. The dry film thickness of the paint was kept constant and the peak metal temperature was changed in an acceptable range and the effect on the texture was investigated. Increasing dry film thickness caused a noticeable change on the texture whereas effect of change in peak metal temperature was negligible.

*Key Words: Coil Coating, Wrinkle, PPG, Wrinkle paints*

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### 1. Introduction

Paint is a coating applied to any object to give color or to protect. It is a chemical component that protects the surface against physical and chemical effects by

forming a film layer on the applied surface and provides a decorative appearance at the same time.

Painted sheets can be classified as follows according to types of polymers which play a binding role in the content of the paint used [1].

- High Durable Polyester
- Wrinkle Polyester
- PUR-PA
- Polyurethane
- PVDF
- Plastisol

Wrinkled coatings have high resistance to atmospheric effects and good bendability because of high durable polyester resin. On the other hand due to the textured surface, snow piles can not hold on to the roof and the surface can easily be cleaned. These advantages provide this product to be highly preferred in the roofs of constructions placed in northern or high altitude regions in many countries.

With the use of pigments causing specific images, unique visual effects like matt brightness (1-10 gloss) can be obtained.

In UV classification, product is considered as RUV3.

With the use of special chemicals, during drying process, a solvent evaporates and as a result a thin layer of the film contracts by volume, forming the wrinkle effect. A rapid curing is seen in the upper layers of the film compared to the lower layers. While the lower layers are still fluid, the upper layers have less fluidity. This crust forms a wrinkle effect.

Factors like curing, film thickness, catalisors, type and amount of crosslinkers are some of the factors that have an influence on the mechanism and final Appearance of the wrinkle. Other paint components like pigment and solvent also have a big effect on the texture of the wrinkle. Therefore, it is possible to get different sized wrinkles for different colours of paint.

With small modifications in the parameters of productions lines, wrinkling process can be applied smoothly as in standard paint applications.

Wrinkled polyester products, that provide a fine and rough surface effect, are highly preferred for roofing and siding applications. When compared with ceramic roof tiles, Wrinkled Polyester has many advantages; As they are much lighter than tiles, covering the roofs is much easier and much faster. Repairs can be operated and concluded easily due to big pieces of steel sheets. They are suitable for covering

flatter roofs without any water leakage through joints. Snow easily slides down from the roof and the roof is less sensitive to any kind of dirt. The look in the roofs or sidings is very esthetic. Another usage of wrinkle applications is in garage doors [7].

Curing temperature, dry film thickness, catalysts in the dye content, type and amount of crosslinker; These are the factors that directly affect the effect by affecting the crease mechanism [1]. In this study, the effect of dry film thickness and curing temperature on the color deviation of Wrinkle Polyester RAL 3009 dye and the size of the wrinkled surface effect was investigated.

## 2. Experimental Studies

### 2.1 Materials

All samples used in this study were produced by MMK Metallurgy Dörtyol galvanizing line. Samples were pre-treated with  $\text{Cr}^{6+}$ , coated with 0.45 mm, 100g / m<sup>2</sup> zinc and passivated in DX51D steel grade. After galvanizing process, 5 µm chromate-free white primer [SP (CF)] was applied on the dyeing line and made ready for wrinkle application. The lined sheets were sized 15 x 20 cm in the laboratory and SP Wrinkle RAL 3009 was applied on them.

### 2.2 Devices and Equipment

Rds 24, RDS 28, RDS 30, RDS 32, RDS 38, Sheen 1850, Sheen 1836 applicators were used to apply SP Wrinkle RAL 3009 paint on the lined sheets used in the study. Reatec temperature-indicators (PMT band) for curing control, Alborh Furnace for curing, Erichsen Paint Borer 518 MC for dry film thickness measurement, Erichsen TRI-GlossMaster (65°) for brightness cone, X-Rite Ci7800 (d/8 geometry, spin) for color control.

### 3. Conclusion

In order to understand paint thickness effect; samples, produced in coating line with 5  $\mu\text{m}$  primer, were painted by applicators in different wet paint thicknesses. Since the guaranteed dry film thickness of wrinkle coatings is 18-22 $\mu\text{m}$  [1], 20  $\mu\text{m}$  paint thickness was aimed in the range  $\pm 6\mu\text{m}$ . The paint was cured at 232 $^{\circ}\text{C}$  in the furnace according to the technical data document recommended by the paint manufacturer [6].

The determination of dry film thickness of samples prepared by applying as wet paint in the laboratory and cured in the oven was made in accordance with the ISO 2808 standard 6B method [2]. Brightness measurements were made in accordance with EN 13523-2 standard [3] and color measurements were made in accordance with EN 13523-3 standard. [4]

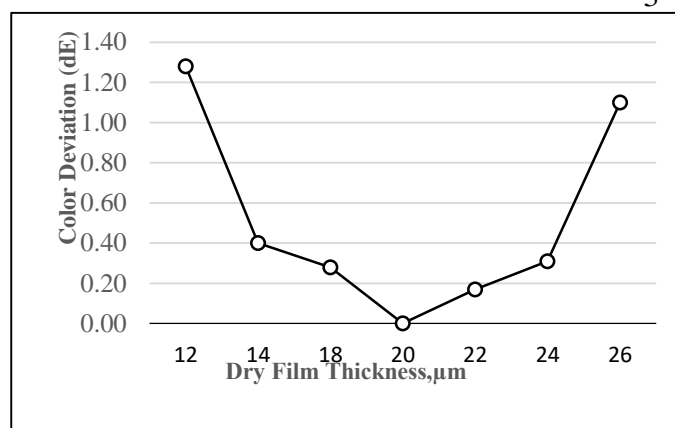
In order to understand the effect of curing temperature; the wrinkle RAL 3009 paint was painted with 20  $\mu\text{m}$  thickness and was cured at different temperatures in the range of 199-260 $^{\circ}\text{C}$ .

#### 3.1 Change of Color Deviation with Dry Film Thickness

The color deviation measurements of samples are measured according to standard color panels which is cured at 232  $^{\circ}\text{C}$  and has thickness 20  $\mu\text{m}$ . all samples were cured with peak metal temperature (PMT) 232  $^{\circ}\text{C}$ .

**Table 1:** Change of color deviation (dE) at constant temperature with dry film thickness

Temperature, ( $^{\circ}\text{C}$ )	Dry Film Thickness, $\mu\text{m}$	Color Deviation,(dE)
232	12	1,28
232	14	0,40
232	18	0,28
232	20	0,00
232	22	0,17
232	24	0,31
232	26	1,10



**Figure 1:** Change of color deviation (dE) at constant temperature with dry film thickness

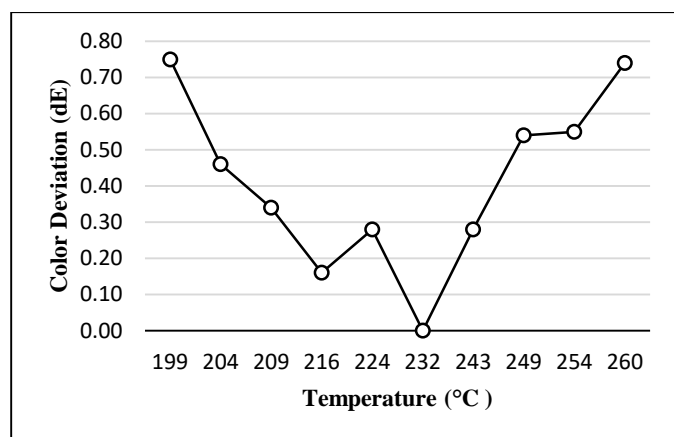
The color deviation due to dry film thickness (dE) between 14-24  $\mu\text{m}$  is not much whereas the color deviation of low and high thicknesses (12,26  $\mu\text{m}$ ) is high.

#### 3.2 Change of Color Deviation with Temperature

One panel with a dry film thickness of 20  $\mu\text{m}$  and a peak metal temperature of 232 $^{\circ}\text{C}$  PMT is stored as standard on the color spectrophotometer instrument. The color deviation of samples cured at different temperatures have same paint thickness 20  $\mu\text{m}$  and their color are measured according to standard panel. (Table 2)

**Table 2:** Change of color deviation (dE) at constant dry film thickness with temperature

Dry Film Thickness, $\mu\text{m}$	Temperature, ( $^{\circ}\text{C}$ )	Color Deviation,(dE)
20	199	0,75
20	204	0,46
20	209	0,34
20	216	0,16
20	224	0,28
20	232	0,00
20	243	0,28
20	249	0,54
20	254	0,55
20	260	0,74



**Figure 2:** Change of color deviation (dE) at constant dry film thickness with temperature

According to the measurement results, the effect of temperature change on color deviation is less than the effect of thickness change on color deviation.

### 3.3 Change of Brightness with Dry Film Thickness

The brightness measurement of the samples applied in different thicknesses are given in Table 3. All panels are cured at a peak metal temperature of 232 °C (PMT). According to the data in Table 3, it was observed that the brightness does not change with dry film thickness, specific to this paint.

**Table 3:** Change of brightness (%) at constant temperature with dry film thickness

Temperature, (°C)	Dry Film Thickness, $\mu\text{m}$	Brightness (%)
232	12	3
232	14	3
232	18	3
232	20	3
232	22	3
232	24	3
232	26	2

### 3.4 Change of Brightness with Temperature

The panels, which are applied as 20  $\mu\text{m}$  (standard), are cured at different temperatures. The brightness of the panels applied and the change in temperature are given in Table 4.

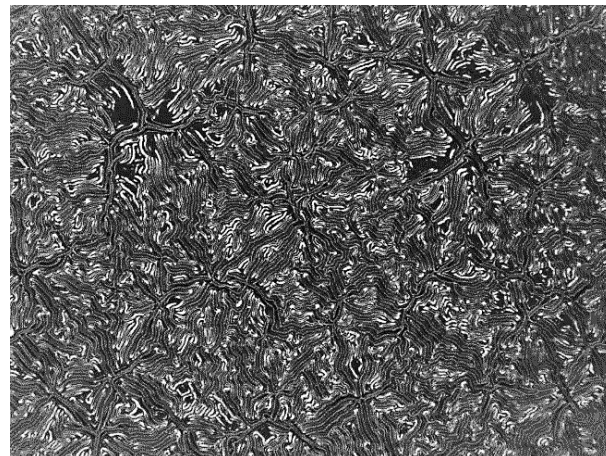
According to these data, it has been observed that the brightness does not change with temperature in relation to this paint.

**Table 4:** Change of brightness (%) at constant dry film thickness with temperature

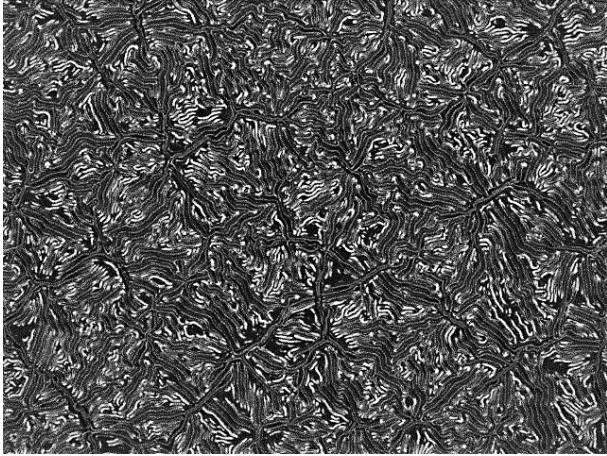
Dry Film Thickness, $\mu\text{m}$	Temperature, (°C)	Brightness (%)
20	199	2
20	204	2
20	209	2
20	216	2
20	224	2
20	232	3
20	243	3
20	249	3
20	254	3
20	260	3

### 3.5 Change of Wrinkle Effect with Dry Film Thickness

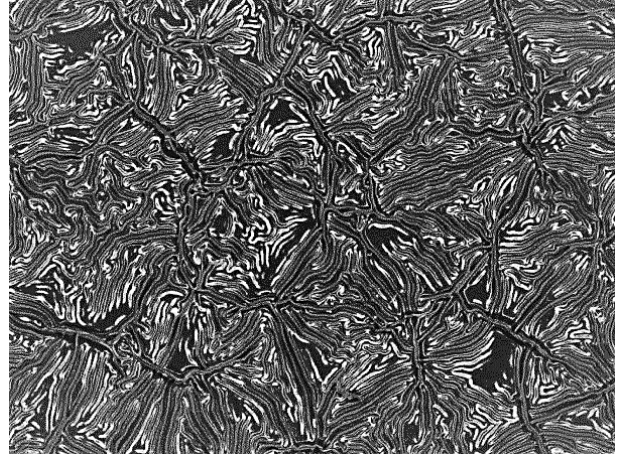
In order to understand the effect of thickness change on the wrinkle effect, all panels applied with different thicknesses were cured at a peak metal temperature of 232 °C (PMT)



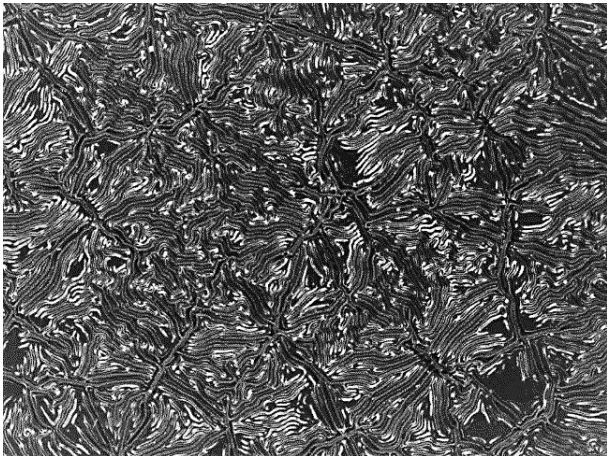
**Figure 3.** 12  $\mu\text{m}$ , PMT (232°C)



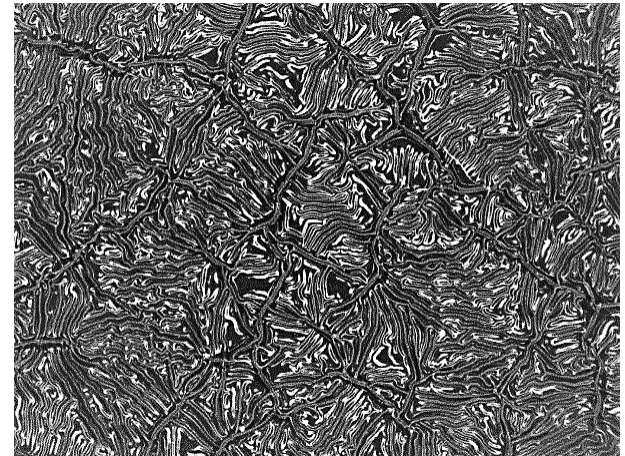
*Figure 4. 14 μm, PMT (232°C)*



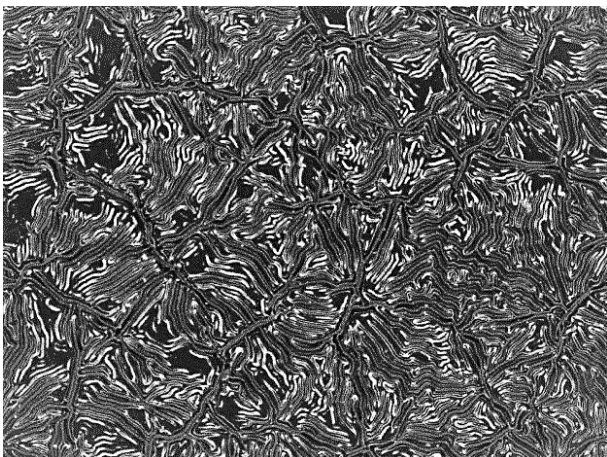
*Figure 7. 20 μm, PMT (232°C)*



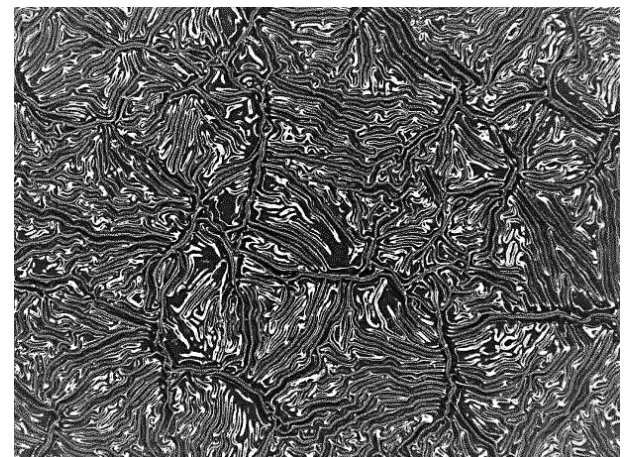
*Figure 5. 16 μm, PMT (232°C)*



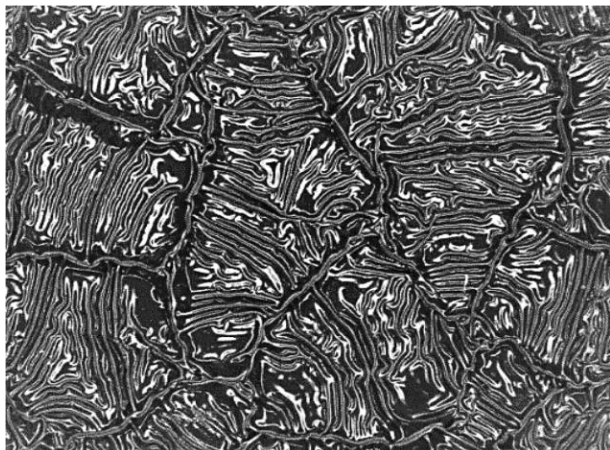
*Figure 8. 22 μm, PMT (232°C)*



*Figure 6. 18 μm, PMT (232°C)*



*Figure 9. 24 μm, PMT (232°C)*

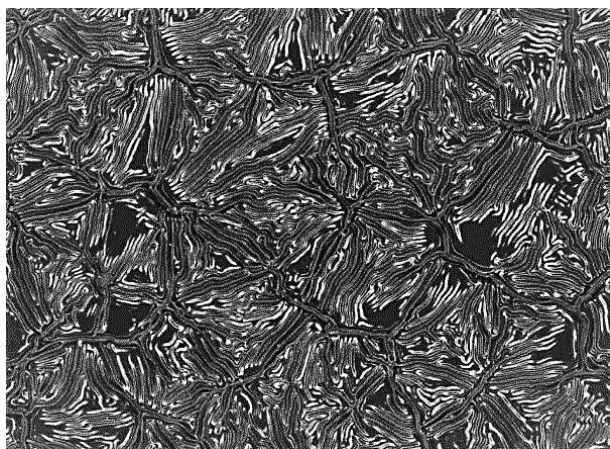


*Figure 10.* 26  $\mu\text{m}$ , PMT (232)

The standard application thickness of wrinkle paints is 20 microns. When the surface pictures were examined, it was seen that the wrinkle effects increased as the dry film thickness increased. In the winding process after the production, the stigmas of the big effects are deformed by rubbing on the bottom surface.

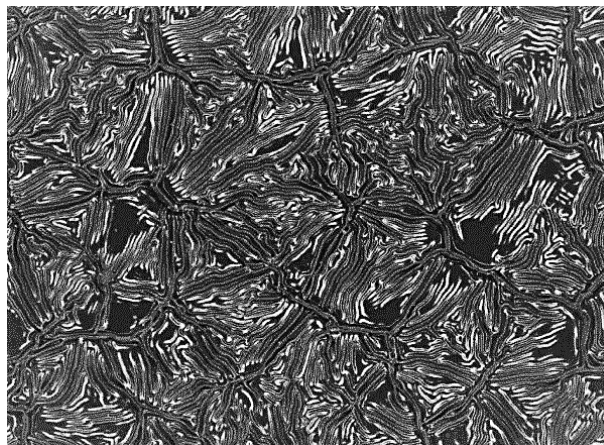
### 3.6 Change of Wrinkle Effect With Temperature

All panels applied standard 20 microns and cured at

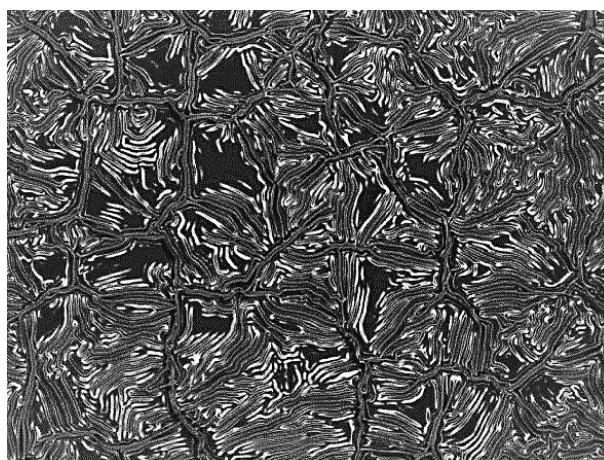


different temperatures

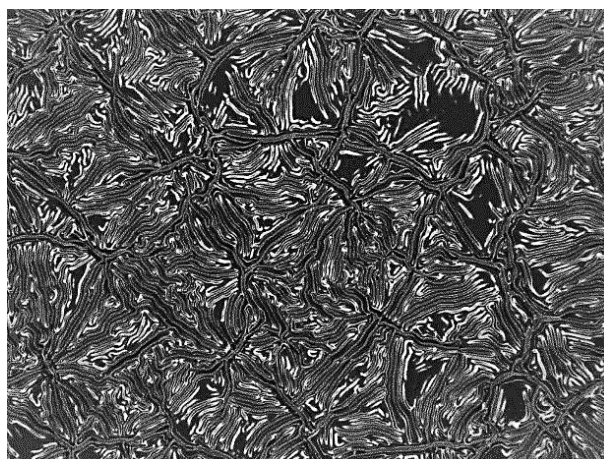
*Figure 11.* 20  $\mu\text{m}$ , PMT (199°C)



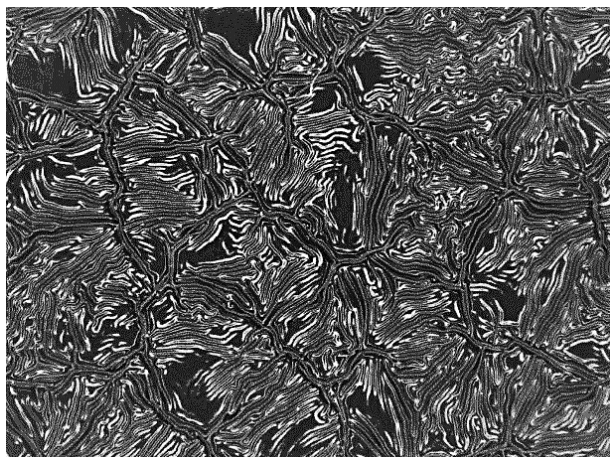
*Figure 12.* 20  $\mu\text{m}$ , PMT (204°C)



*Figure 13.* 20  $\mu\text{m}$ , PMT (209°C)



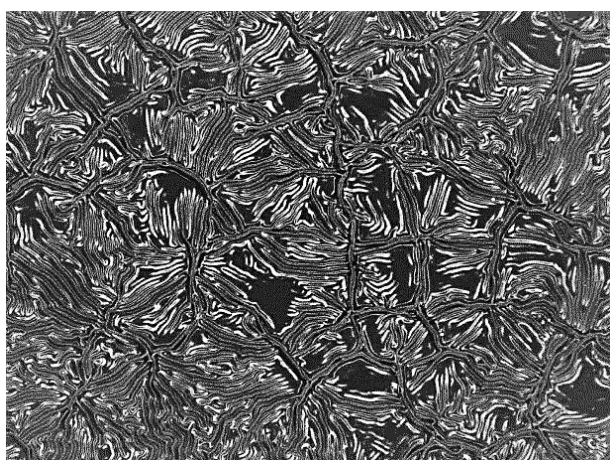
*Figure 14.* 20  $\mu\text{m}$ , PMT (216°C)



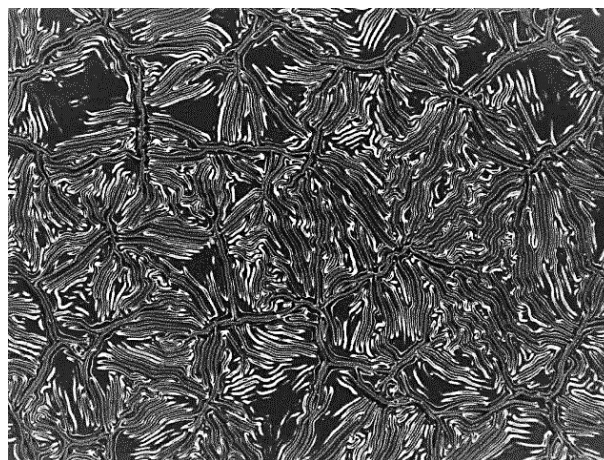
**Figure 15.** 20  $\mu\text{m}$ , PMT (224°C)



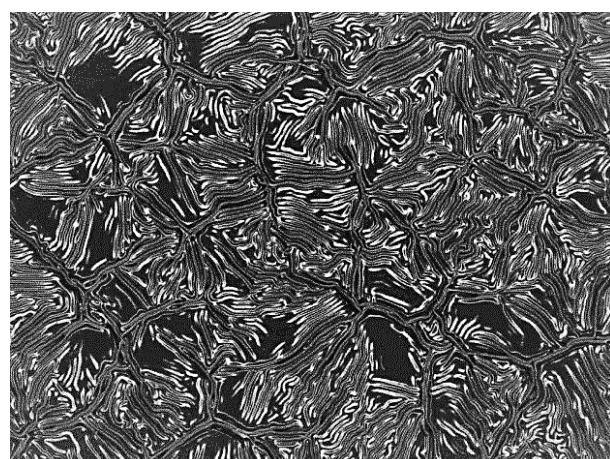
**Figure 18.** 20  $\mu\text{m}$ , PMT (249°C)



**Figure 16.** 20  $\mu\text{m}$ , PMT (232°C)



**Figure 19.** 20  $\mu\text{m}$ , PMT (254°C)



**Figure 17.** 20  $\mu\text{m}$ , PMT (243°C)

When the surface pictures are examined it was observed that increasing the curing degree had no effect on the wrinkle effect for this sample.

## References

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