

**“TOYOLAC” Plating Grade ABS Resin**

# TECHNICAL GUIDE

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**1. INTRODUCTION**

“TOYOLAC” is the trade name of Toray’s thermoplastics that is known as ABS polymer (Acrylonitrile-Butadiene-Styrene resin) in regular use for the past thirty years. “TOYOLAC” has lightness, toughness and attractive appearance, and ensures excellent mechanical, thermal, chemical, electrical properties and well balanced mold ability. It is used in wide range of applications including industrial material and household articles.

**2. FEATURE OF “TOYOLAC” PLATING ABS**

“TOYOLAC” Plating grade ABS is designed for plating applications particularly in automotive industry in which aesthetic appearance is strongly emphasized. This grade has successfully overcome several plating process problems such as crazing and weak plating adhesion which were encountered by general ABS. The most attractive characteristics of “TOYOLAC” plating grade is they offer balance properties of flow and impact strength yet with competitive price.

Feature	"TOYOLAC" PLATING GRADE	GENERAL ABS RESIN
Moldability	⊙	⊙
Mechanical Property	⊙	⊙
Plating Property	⊙	Δ
Cost	○	⊙

⊙ : Best	○ : Good	Δ : Moderate
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General Properties of plating grade “TOYOLAC” 315 X01, “TOYOLAC” 325 and “TOYOLAC” 335 MPL ABS are shown in below Table 1.

PLATING 电镀型						
Property 代表物性	Test Method 试验法	Test Condition 试验条件	Units 单位	High Flow 高流动	Standard 一般	High Flow High Impact 高流动 高抗冲击
			Type 型号	315	325	335
			Suffix 区分字符	X01		MPL
ISO STANDARD						
Melt Flow Rate 流动系数	ISO 1133	220°C / 10 kg	g/10min	24	15	24
Charpy Impact Strength (notched) 缺口冲击强度	ISO 179/1eA	23°C / 50 %RH	kJ/m <sup>2</sup>	24	25	32
Deflection Temperature Under Load 热变形温度	ISO 75	1.8 MPa / 120°C/hr	°C	81	81	83
Tensile Strength 引张强度;降伏点	ISO 527	50 mm/min	MPa	47	47	44
Tensile Elongation at Break 拉伸伸长率			%	>10	>10	>6
Tensile Modulus 拉伸模数			1 mm/min	MPa	-	2500
Flexural Strength 弯曲强度	ISO 178	2 mm/min	MPa	69	69	67
Flexural Modulus 弯曲模数				2300	2280	2330
Density 比重	ISO 1183	23°C	kg/m <sup>3</sup>	1040	1040	1040
Flammability 燃烧性	UL94 File No. E41797			HB	HB	HB

Note: The above values are typical data for the products under specific test conditions and not intended for use as limiting specifications.

「以上数据谨代表在特定条件下所得的测定值的代表例」

Table 1: Catalogue Properties Data

### 3. PROCESSING CONDITION

#### Drying

Commonly, ABS resin absorbs moisture in proportion to environmental humidity. The absorbing process of moisture is a reversible process. Therefore, moisture of wet pellets will be lost to environmental air with lower humidity. Dried pellets should absorb moisture until the amount touches equilibrium amount with the moisture in the air. The absorbing moisture content depends on the relative humidity in the air and how long the resin was exposed. While “TOYOLAC” ABS resin is exposed to humidity, the moisture is absorbed onto surface and into inside of the pellets itself, recycled materials or molded parts. Typical equilibrium moisture of “TOYOLAC” Plating Grade ABS is around 0.2~0.3% at 23°C, 50%RH, and 0.5~0.6% at 40°C, 95%RH. The rate of absorbed moisture depends on pellet size, shape and environmental temperature. Non-dried ABS resin can cause silver streak problem on molded parts. The recommendable moisture content for “TOYOLAC” Plating Grade ABS is less than 0.1%, more desirable is 0.05%. Generally, below drying conditions are recommended.

**<Internal air circulation oven>**

**Drying Temperature : 80 ~ 90 °C**

**Drying Time : 5 ~ 3 hours**

**<Hopper dryer>**

**Drying Temperature : 80 ~ 90 °C**

**Drying Time : 3 ~ 2.5 hours**

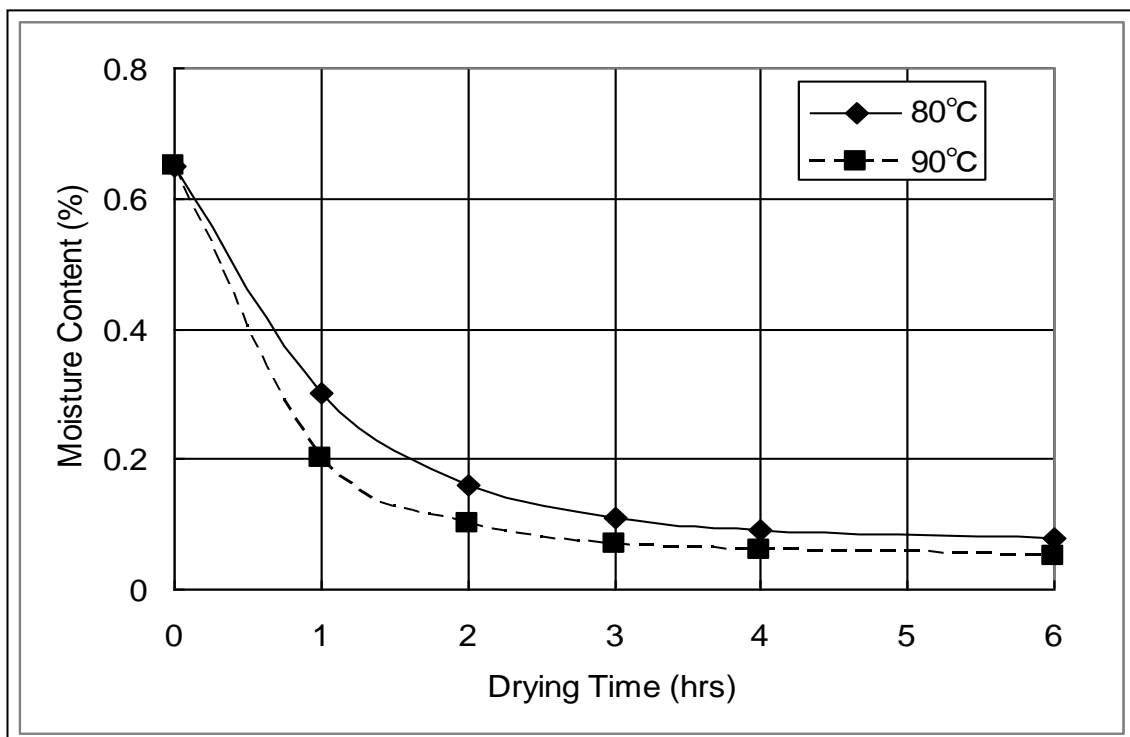


Figure 1: Drying Variable of “TOYOLAC” Plating Grade ABS

### Injection Molding Condition

The most common trouble happens to ABS resin when undergone plating process is swelling of plating film. Apparently this trouble is mostly caused by improper molding condition which subsequently resulting to abnormal orientation of rubber in ABS resin. Thus, it is important to optimize molding condition to reduce rubber orientation in order to obtain good plated molded part. Below are three main parameters for reference. Please refer *Plating Peeling Strength* for the correlation of molding condition and plating film adhesion strength.

- Higher resin temperature
- Slower injection speed
- Higher mold temperature

### Injection Barrel Temperature

Generally, the barrel temperature of injection molding machine should increase from the hopper to the nozzle gradually. "TOYOLAC" Plating Grade ABS starts softening at around 90~110°C. Standard molding condition is shown as below.

Nozzle	Zone 4	Zone 3	Zone 2	Zone 1	Hopper
230 - 250 °C	230 - 250 °C	230 - 250 °C	230 - 250 °C	230 - 250 °C	220 - 230 °C

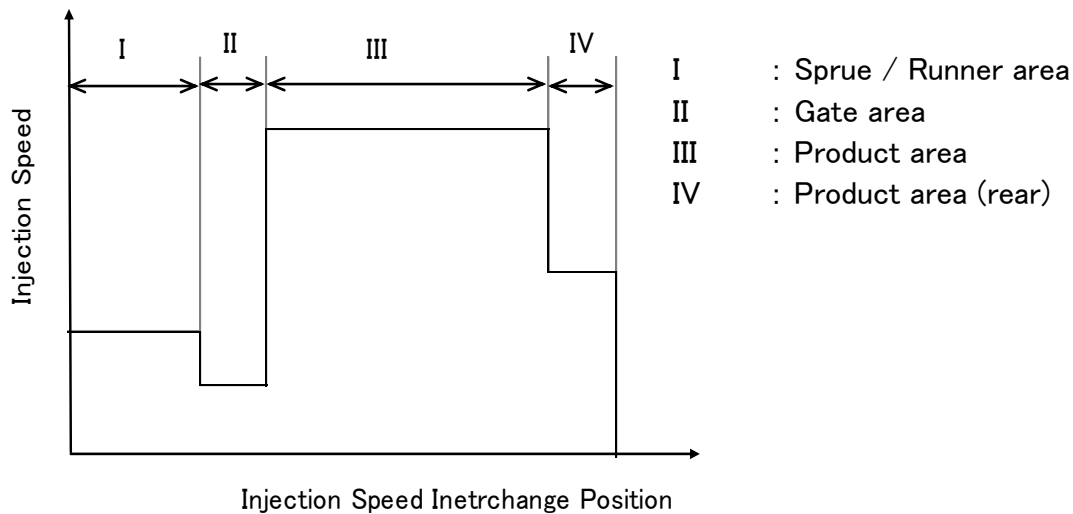
It should be properly controlled according to the injection molding machines, the shapes and size of the products, and the mold structure. Excessive temperature than recommended above could result in discoloration or burn marks problems. These are signs of damage to the material. Melt temperature of resin should be between 250~ 260°C. It should be checked frequently and maintained within above recommended range to prevent defect to appearance and mechanical properties. Besides, too low temperature under hopper might cause injection screw to drag air into barrel and resulted silver streak problem. If shutdown is required, remove the material from the machine and purge out completely to avoid burning trouble.

## Injection Speed & Pressure

Injection speeds will depend on products shape, gate structure and runner dimensions. Basically moderate injection speed is preferable in order to prevent orientation of rubber particles due to excessive shear. Thus, the basic concept to avoid excessive rubber orientation is to slow down the flow front speed. The relationship of flow front speed and injection speed is illustrated in following formula.

$$V = Q / A = ( S \times V_s ) / A$$

- V : Flow front speed (cm/s)  
 V<sub>s</sub> : Injection speed (screw forward speed) (cm/s)  
 Q : Injection ratio (cm<sup>3</sup>/s)  
 A : Channel cross section area (cm<sup>2</sup>)  
 S : Screw cross section area (cm<sup>2</sup>)



*Figure 2: Injection Molding Parameter Setting*

Injection speed is reduced at gate area but insufficient injection speed when entering the product area with large cross section area channel will induce wavy flow mark, weld line and other molding defects. Thus, the most effective method to optimize molding parameters setting is to determine the flow front speed rather than injection speed (screw forward speed).

Injection speed is reduced when approaching the product rear area to prevent material burnt caused by adiabatic compression.

## Mold Temperature

The mold temperature affects the surface quality and the level of residual stress in the molded products. To provide a molded product having excellent surface finish, less residual stress and lesser rubber ovality, the mold temperature should be controlled >60°C. However, higher mold temperature may cause longer cycle time and warpage problem. Excessive mold temperature should be avoided.

The keys molding conditions to achieve good plated molded part are summarized in Table 2.

Molding Process	Condition
Mold release agent	Totally prohibited (eg: silicon type)
Injection machine cylinder temperature	Slightly higher than normal ABS resin setting (230 -250°C)
Mold temperature	Higher side (60 - 80 °C)
Injection speed	At slower speed
Holding pressure	At lower side and shorter time

*Table 2: Optimum Injection molding condition for “TOYOLAC” Plating Grade ABS*

## Purging

General maintenance and equipment cleaning should include frequent purging with natural color ABS resin or AS resin. If prolonged shut-down is required, reduce barrel temperature less than 150°C, remove the material from the injection machine and purge with natural ABS resin or AS resin. Continue this operation until hopper is empty throughout and confirm barrel temperature has been dropped less than 150°C.

## Regrind

Runners, sprues and shot-shots of “TOYOLAC” Plating resin molded under proper molding conditions can be used for recycle materials. Those non-degraded regrind up to a 20% can be reprocessed with fresh pellets of the same grade. Please do not mix it up with other grades of “TOYOLAC” resin or other plastics. Drying is necessary before reprocessing.

**5. PLATING PROCESS**

**Basic Schematic Illustration**

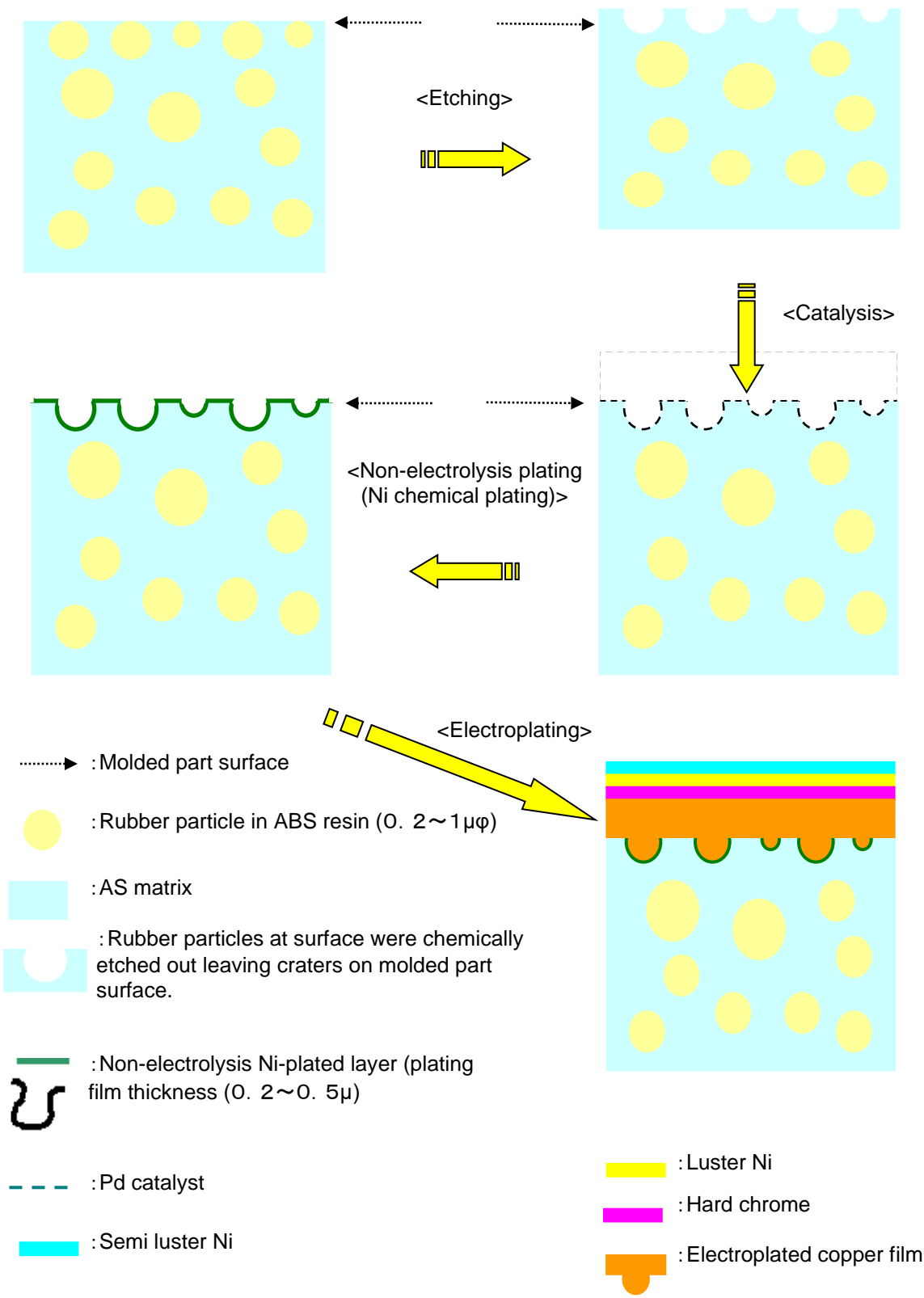
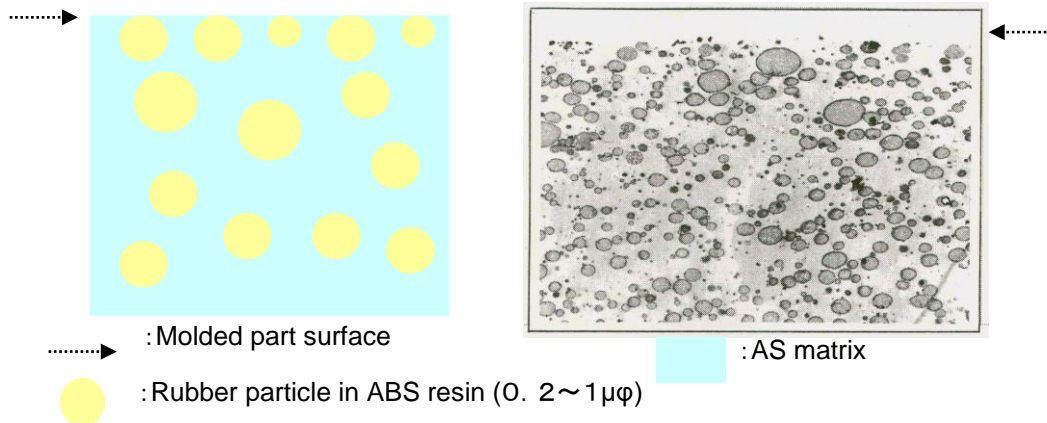


Figure 3: Basic schematic illustration of plating process

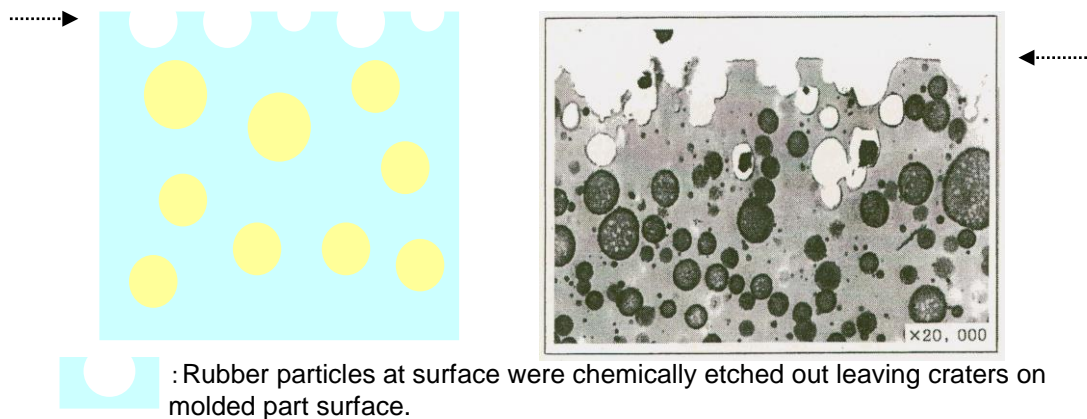


## ABS Resin Morphology

(1) ABS resin molded part surface area morphology before etching



(2) ABS resin molded part surface area morphology after etching process



(3) ABS resin molded part surface area morphology upon chemically plated by Ni

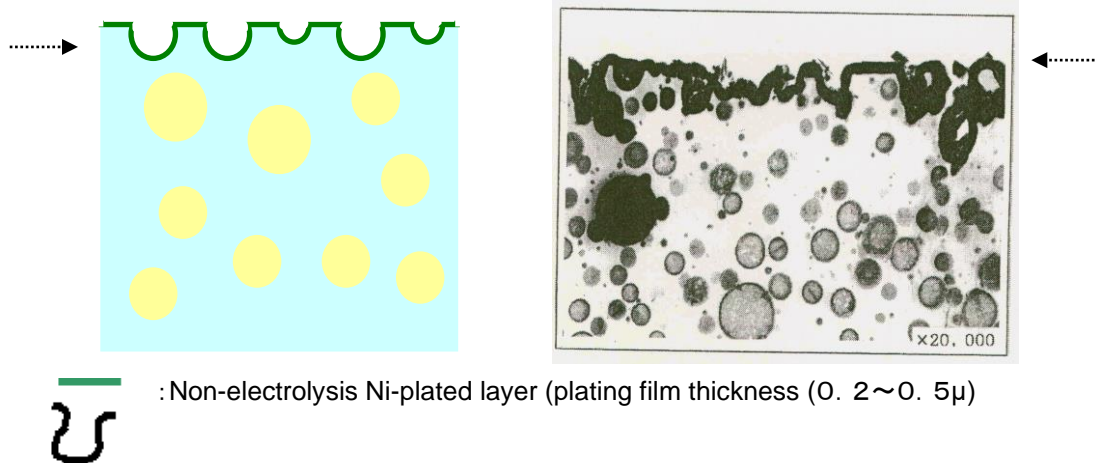
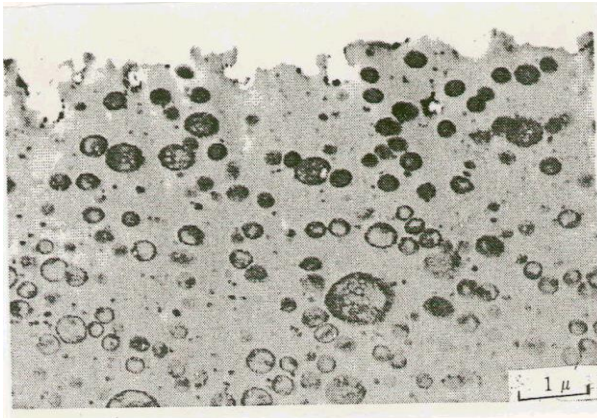
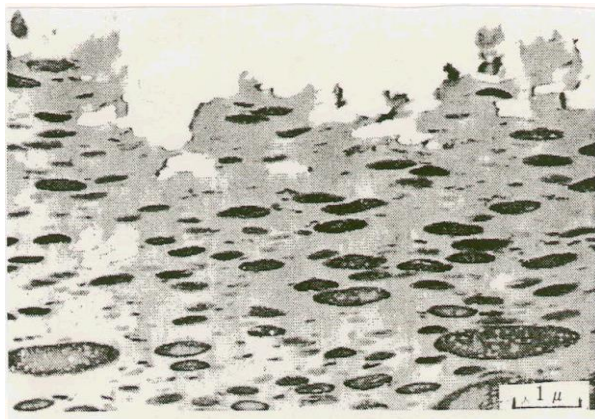


Figure 4: Plating film peeling strength analysis via Transmission Electron Microscope (TEM)

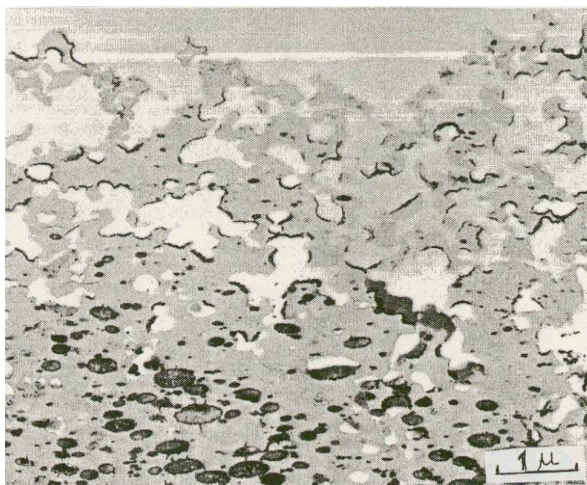
## Effect of ABS Resin Morphology



Suitable morphology for plating process. Round shape rubber particles give round craters after etching which provide good anchoring effect during plating process. Less rubber orientation achieved via proper injection molding conditions setting.



Flat oval shape rubber particles indicate strong orientation. Molded part surface craters formed after etching are shallow thus weak anchoring effect is expected. Modification in molding conditions or product shape is necessary to avoid defect during plating process.



Molded part surface shows deep penetrating craters into ABS resin caused by over etching. Etched surface becomes brittle and no suitable anchoring crater is observed. Over etching might cause by severe plating condition (eg. excessive etching) or improper plastics resin selection.

*Figure 5: ABS Resin Morphology Effects on Plating Process via TEM*

**Important Notes:**

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