Coatings on fastener heads are almost blended by synthetic resin as it is applicable to steel products. Currently, anti-rust, chemical resistant, heat resistant, oil-free, antifouling, and abrasion-resistant coatings are all applied on fastener heads. These coatings are used for aesthetic and decorative applications. They are also equipped with protective and corrosion resistant functions. However, no commonly used method is applied to tests of functions and quality of coatings on fastener heads. This article will expound upon testing items and methods for coating films that are often used in labs and served as reference to the industry.

Coating film testing items include thickness, appearance, physical/chemical property, and environmental testing. These tests cannot be directly conducted on fastener heads and must be done by sample plates. However, sample plates must be specifically prepared and simultaneously handled with coating processes on fastener heads, so that sample plates can obtain the consistent film property of fastener heads.

Quality Test of Coatings on Fastener Heads

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1. Film Test- Appearance

Appearance inspection of coatings on fastener heads mainly includes the measurement of gloss and chromatic aberration.

1.1 Gloss

Measurement of film gloss uses the geometric 20°, 60° or 85° reflectometer. Geometric 60° applies to all films; however, geometric 20° is more appropriate to highly glossy films. It would be proper for gloss-less films to use geometric 85°. Reference standard is ASTM D523.

1.2 Chromatic Aberration

It applies to uniform color (i.e. monochrome) films while checking with general color sense. Two sampled film chromatic coordinates are used to calculate the chromatic aberration. Currently there are many formulas to calculate the chromatic aberration. International Commission on Illumination (CIE) recommends (L* a* b*) be used to calculate the chromatic aberration. Its test of chromatic aberration has been proven to conform to the actual value very closely. The test result is indicated by △ E. The smaller the value, the smaller difference between the two colors. Reference standard is ASTM D2244.

2. Coating Film Test- Physical & Chemical Property

Physical and chemical property tests of coating films on fastener heads include film hardness, adhesion, abrasion resistance, pollution resistance, acid/alkali resistance, and heat resistance.

2.1 Hardness (with a Pencil)：

The pencil test indicates that a pencil with a known hardness is pressed on the surface of a film, resulting in scratches or other destructive film resistance. Film hardness is thus noted according to the hardness of the pencil. The pencil test is quick, cheap and is used for comparing the hardness of different films. Reference standard is ASTM D3363.

2.2 Adhesion

This test method cuts the film with a checkered pattern and penetrates to the substrate for assessing the film resistance to peel from the substrate. The tested function is dominated by adhesion of the film toward primer or substrate. The assessment is divided into 6 grades. Reference standard is ASTM D3359.

2.3 Abrasion Resistance

The test method uses a grinding wheel and applies specified load to test the abrasion of a film. Reference standard is ASTM D4060.

2.4 Pollution Resistance/ Acid & Alkali Resistance

According to a customer's demand, the sample is immersed in the test solution for observing its influence on the film and assessing the result, such as changes of coating colors or gloss, or blistering, softening, swelling, etc. Test conditions include (1) test solution and its concentration (such as: sodium hydroxide

solution (5%), sulfuric acid solution (10%), volatile oil); (2) test temperature; (3) test time. Reference standard is ASTM D1308.

2.5 Heat Resistance

The test applies to high temperature resistance of the film. Under a proper high temperature, the test intends to realize the change of gloss, color, blistering, cracking, or peeling on the coating. The test applies to heaters at home or other products that need to endure high temperature. The test temperature and duration is 125℃ and 24 hours respectively.

3. Environmental Tests of Films

The environmental tests of coating films on fastener heads include salt spray, weather resistance, and humidity resistance.

3.1 Salt Spray

The corrosion resistance test applies to the steel and the test time is designated by a customer. The judgment will be made according to whether corrosion or blistering occurs when the test time is out. If it is possible, the appearance can be compared with a standard picture to assess the blistering size as well as distribution and density of the corroded area. Reference standard is ASTM B117.

3.2 Weather Resistance

The fluorescent, UV and condensation are used to simulate the deterioration of films caused by sunlight, rain, or dew. UV imposes the photochemical influence on the specimen, and the deterioration of the specimen is in direct proportion to both UV radiation time and temperature. The test condition is the cycle process of 60 ℃ UV radiation for 4hrs and 50 ℃ condensation for 4hrs. When the designated cycle time is out, changes of the appearance before and after the test are observed, such as the change of gloss or chromatic aberration or chalking. Reference standard is ASTM G154.

3.3 Humidity Resistance

The test applies to coating films under the high humidity condition. Its humidity resistance can be checked through changes on coating films. The water permeation rate will be raised due to the increase of condensation time and temperature. The method can assess the performance of films under the adverse environment with high temperature and saturated vapor. The test result can help observe the performance of coating films when blistering, pollution, softening, or wrinkling occurs. Reference standard is ASTM D2247.

Conclusions

Many coatings can be applied on fastener heads. Their main usage includes anti-rust, acid/alkali resistance, heat resistance, antifouling, abrasion resistance, etc. These features can be tested according to the above corresponding test items to confirm if the coatings of heads meet the requirements of customers.

After tests, the failure may occur to coating films on fastener heads, such as changes of gloss or chromatic aberration before and after tests, or blistering, pollution, softening, wrinkling, and so on. Many reasons will cause the above situations. Improper selection of coating, poor film performance, improper pre-surface treatment, pollutant found on the substrate of a fastener, or poor manufacturing process could lead to the failure of coating films on fastener heads. Joint discussion with paint makers is necessary to locate whether the reason lies in fasteners, paints, pre-treatment, manufacturing process, or other sectors. The collaborative problem solving process facilitates fastener makers to gradually grasp characteristics of coatings and increase the quality of coatings on fastener heads. ■