Overview of Coatings and Surface Treatments

Looking around, it is apparent that there are coatings on many everyday objects. The desk you are sitting at is coated with a sealer, the walls of your office are painted, and your cars windows are tinted. According to Wikipedia a coating is a covering that is applied to the surface of an object. The object receiving the coating becomes the *substrate*.. In many cases coatings are applied to improve surface properties of the substrate, such as appearance, adhesion, wetability, corrosion resistance, wear resistance, and abrasion resistance. From an engineering and quality stand point any of these individual properties or a combination thereof can be important in enhancing the service life of a structure or a component.

What is the difference between Coatings and Surface Treatments?

A coating is an organic or inorganic layer that is applied to a surface (substrate) for a variety of reasons. The purpose of the coating may be decorative, such as paint, or it may be to protect the surface of the substrate from the environment (improve corrosion resistance), such as galvanizing. Coatings can also improve wear resistance in mechanical application, or act as a thermal barrier.

Depending on the material and applications, coatings may be one or more layers. The first coat may act as a primer to improve bonding of the top coat, or it may improve the overall properties of the coating system. For example hard chrome plating is commonly porous in nature, so it is applied over a layer of nickel. The softer nickel is continuous and protects the substrate from corrosion, whereas the top chromium layer is very hard and therefore wear resistant.

Surface treatment is a process by which the outermost layer of the material is metallurgically modified, as opposed to coatings, which are applied over a substrate with no effect on the properties of the base material. The most common application of surface treatment is case hardening. The hardness at the surface of the material is increased substantially through various types of thermal treatments, such as carburizing. A common application for case hardening is on bolts and screws. This treatment may also be combined with a coating or plating process, such as galvanized case hardened bolts.

What can coatings and surface treatments impart to the substrates?

As stated above, there are many reasons for wanting or needing a coating on a material or product. Depending on the application, properties such as increased hardness (wear resistance), increased or decreased friction, or a change in thermal expansion or thermal conductivity can greatly enhance the usability of the substrate. In all cases, these properties determine the

What properties are important for the satisfactory application of coatings and surface treated layers to substrates?

With regard to the application of coatings to a substrate, the most important properties are adhesion to the substrate, the correct thickness of the coating itself, and the integrity of the deposited material. Similarly, for surface treatments, the thickness and the soundness of the affected layer will determine the success of the treatment. Depending on the application, properties such as hardness (wear resistance), friction, thermal expansion, and thermal conductivity may also be a consideration.

What properties of coatings and surface treatments may be determined by microscopic examination?

- Thickness

  The most accurate method of measuring the thickness of coatings and surface treatment layers is by the microscopic method. Generally, this method involves polishing samples or coupons removed from a part, followed by various stages of polishing to get a clean cross section. The ASTM standard for this method is B487, Standard Test Method for Measurement of Metal and Oxide Coating Thickness by Microscopic Examination of a Cross Section.

- Adhesion and Soundness of Coatings and Modified Surfaces

  Both the adhesion of a coating and its intrinsic integrity can be evaluated on cross section samples prepared for the thickness measurements. In the case of surface treated metallic parts, the polished sample may need to be etched in order to differentiate between the core material and the modified surface layer.

Testing Engineers' capabilities for evaluation of coatings and surface treatments

TEI has a long history of providing clients with quantative data on their coating and surface treatment issues. In addition, our experience in this field provides valuable qualitative insight. Following are some of our testing capabilities.

- Microscopic Method for Overall Coating Evaluation

  The metallurgical microscope at TEI with digital imaging capacity enables microscopic evaluation of polished surfaces at magnifications of up to 1000X with good resolution. The imaging software includes accurate measuring capability suited to thickness of thin coatings with thickness as low as 0.2 mils (5 microns).

  The examination of the polished cross section at high magnification also allows the uniformity of the bond between the coating and the substrate to be evaluated accurately.

Possible coating defects such as porosity or inclusions may also be observed using the microscopic method.

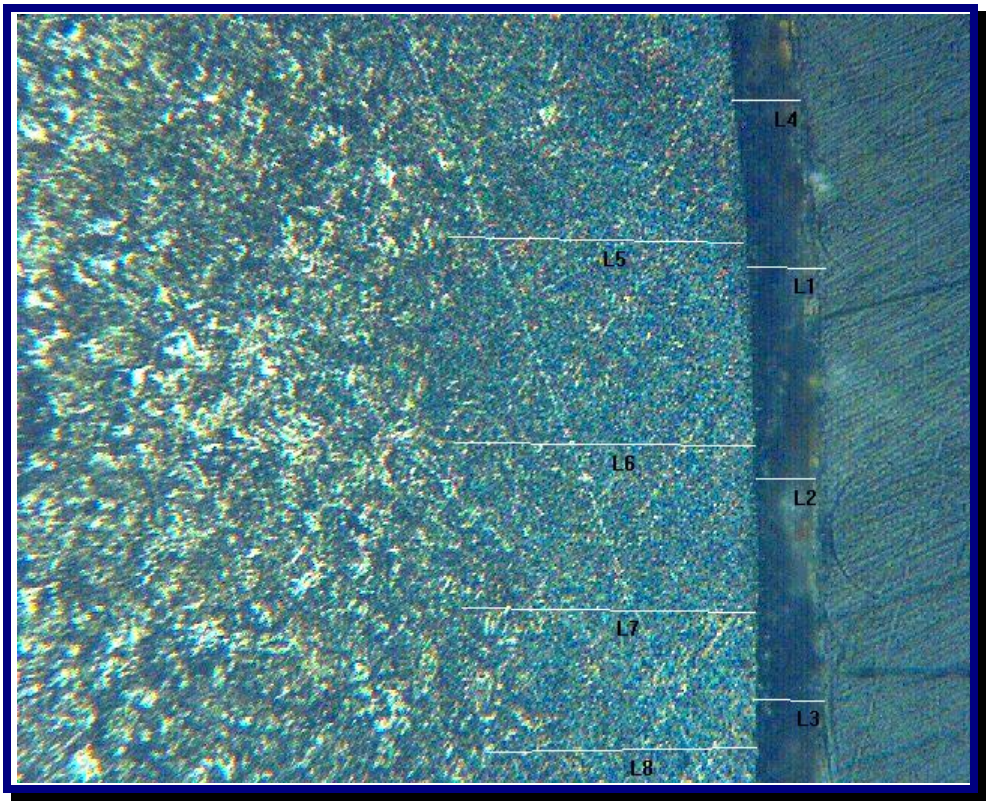
- Additional Tests

  Abrasion resistance of organic coatings can be determined in our laboratory by the Taber Abraser Machine (ASTM D4060 test method).

  Additional test methods offered by TEI include thickness measurement by the magnetic gauge (ASTM Method B499) and bond strength of coatings by the pull-off method (ASTM Method D4541). Both these tests can be performed in our laboratory or in the field.

The information on the coating or surface treatment may be used by our clients for R & D, quality control, or as data by an independent laboratory for promotional purposes, or as part of a larger in-house failure investigation project.

Thickness Determination of Galvanized and Case Hardened Layer on a Steel Bolt



Measurement Data

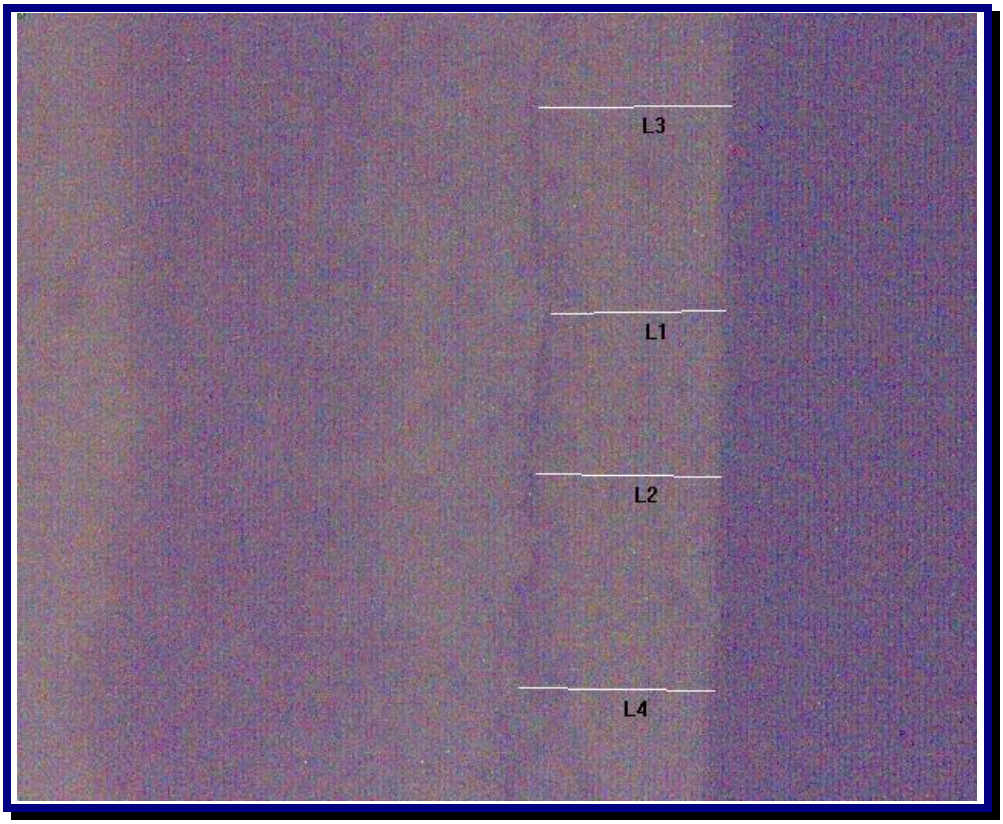
Line	D value
L1	**1.31 mils**
L2	**0.99 mils**
L3	**1.19 mils**
L4	**1.14 mils**
L5	**4.87 mils**
L6	**4.97 mils**
L7	**4.84 mils**
L8	**4.45 mils**

Thickness Measurement of Black Anodized Coating

Measurement Data

Line	D value
L1	**1.19 mils**
L2	**1.09 mils**
L3	**1.11 mils**
L4	**1.16 mils**
L5	**1.14 mils**

Paint Thickness Data



Measurement Data

Line	D value
L1	**5.67 mils**
L2	**6.02 mils**
L3	**6.27 mils**
L4	**6.37 mils**