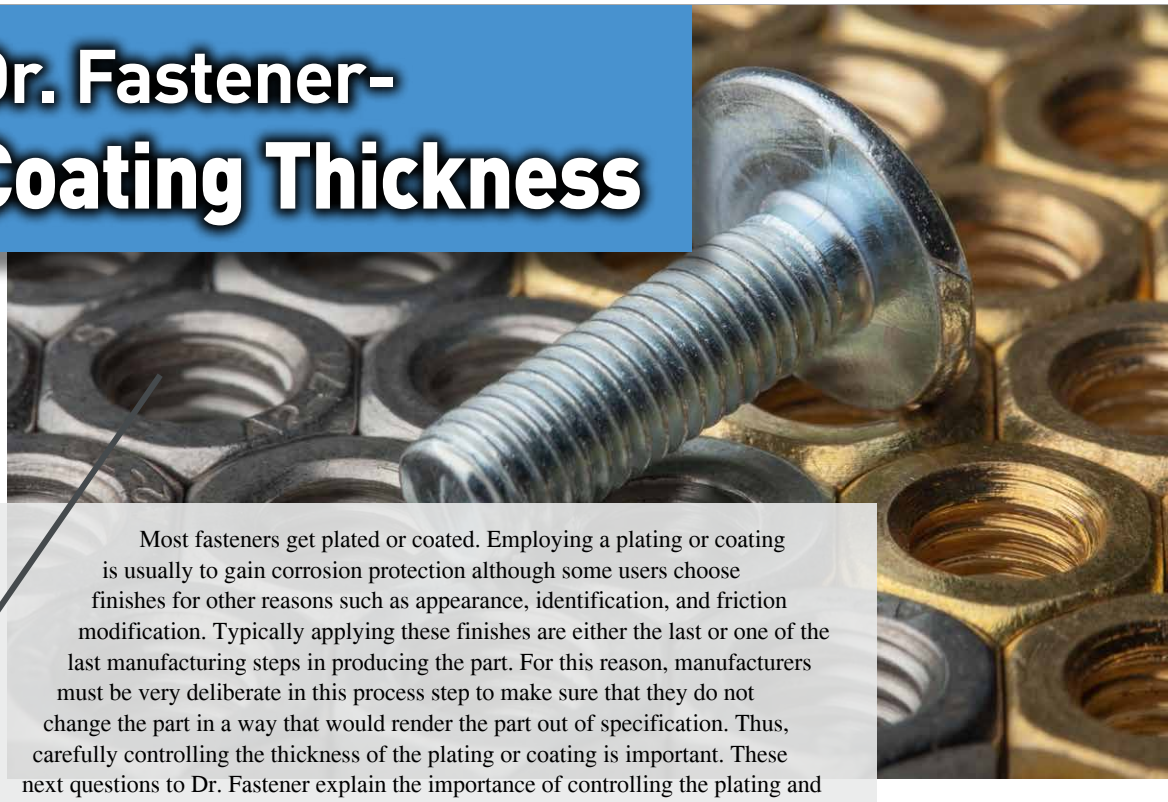
Dr. Fastener- Coating Thickness



Most fasteners get plated or coated. Employing a plating or coating is usually to gain corrosion protection although some users choose finishes for other reasons such as appearance, identification, and friction modification. Typically applying these finishes are either the last or one of the last manufacturing steps in producing the part. For this reason, manufacturers must be very deliberate in this process step to make sure that they do not change the part in a way that would render the part out of specification. Thus, carefully controlling the thickness of the plating or coating is important. These next questions to Dr. Fastener explain the importance of controlling the plating and coating thickness and explore how it is measured and verified.

Q How do Plating or Coatings Dimensionally Influence Fasteners?

A Although we plate or coat parts for a variety of reasons, primarily to protect parts from oxidation, the application of these protective finishes is not without effect on the fastener. In fact, speaking simplistically, most plating and coatings have some thickness, so that application onto the fastener makes the fastener get bigger.

Q Specifically, What Dimensions are Changed?

A In reality, all dimensions covered by the plating or coating are subject to grow. However, **on threaded fasteners the Pitch Diameter is critical in determining how the external and internal threads fit together.** Because the thread geometry adds some complexity to the equation we find that **on a 60° thread, the Pitch Diameter grows by four times (4x) the plating thickness.**

Q Why is That Relationship Important?

A Understanding that the Pitch Diameter grows by four times the plating thickness is very important because it is a strong determining factor in whether a part fits loosely, tightly, or not at all. In other words, if a coating is very thick, like paint might be, the Pitch Diameter will grow significantly and might prevent mating parts from fitting together. Conversely, if a part only receives a thin finish, like a flash zinc plating, the Pitch Diameter will not grow much and the fit might be loose.

Q What is "Throw"?

A Another important surface finishing concept is "throw". Throw is the term used to describe the ability of a plating or coating to deposit in recesses. In other words, **a finish with good throwing capability will uniformly deposit itself in a hole or recess,** while a finish with poor throwing capability may only be able to cover the upper portion of the recess, leaving the depths of the recessed areas uncoated.

Article by Laurence Claus

What is the "Dog Bone" Effect?

There are many factors that effect the efficiency and consistency of electroplating. One of those factors is the principle of electric current density. A metal part that is to receive an electroplating will exhibit variation throughout the part in the amount of electric current flowing through a given area. Examining that more closely, it means that an electrical current will flow differently through a fastener. In fact, **the electric current density is higher at the ends than in the middle of a typical fastener part. This results in the plating depositing quicker and more efficiently at the ends than in the middle.** The outcome, therefore, is a fastener with more plating at the ends, resembling a bone. Thus, the reason this is known as the "dog bone" effect. For fasteners, the implication of this is that threads are almost always on one end of the part, so that a thicker deposit of plating on the threaded end can result in thread fit issues. This is particularly true of externally threaded bolts and screws that possess a long and skinny aspect ratio.

What are Other Implications of Plating and Coating Thickness?

Plating and coating's primary purpose is to protect the base fastener from corrosion and oxidation. Today's plating and coatings are normally multi-element systems, meaning that they have several different elements working together as a system to protect the part. Take for example a typical zinc plated fastener, that system is comprised of an electroplated layer of zinc, a chromate conversion layer, and a sealer. These three separate elements work together to protect the fastener. The thicker the plating or coating layer, the longer it protects the part.

Why do We Measure Plating or Coating Thickness?

Since the thickness of the plating or coating layer is usually an effective indicator of protection as well as how the threads will fit together, it is a characteristic that many manufacturers or users will want to verify and control it.

How is the Plating or Coating Thickness Measured?

There are several methods that can be employed to measure the plating and coating thickness:

- **Cross section:** One of the most accurate methods of obtaining the plating or coating thickness is to section the part and measure the actual plating or coating thickness under magnification. Although this method can be extremely accurate, it is also quite time consuming and requires specialized equipment that can view the part under high magnification.
- **X-ray Fluorescence (XRF):** XRF excites the sample with X-rays that cause it to emit other x-rays that can be analyzed to determine thickness and composition of certain plating or coatings.
- **X-ray Diffraction (XRD):** Although XRD is more commonly used to study the crystalline structure of some platings (such as the zinc-alloy coatings), it can be employed to provide thickness details as well.
- **Eddy Current and Eddy-Mag:** These methods are commonly used by fastener labs to verify plating thickness. They use reference samples to distinguish a reference to evaluate parts against. ■