AST
ADVANCED SURFACE TREATMENTS

60 SECOND INSIGHT

BLACK SPOTTING

Black spotting has been around for as long as electroplating, but what actually is it and should it be a concern?

Black spots are generally understood to be a phenomenom that can occur on electroplated parts weeks or even months after processing. They also usually appear without any other signs of typical coating corrosion and hence quickly become a cause for alarm. It is often the case that the supplier will have packed and the customer will have received perfectly conforming parts, only to return to stock at a later date to find black spot development

Black spots are not unique to any particular type of coating and can be prevalent on acid or alkaline processes, with zinc and zinc alloy layers, with and without post treatments and with no discriminant between trivalent and hexavalent passivates. As such they are independent of the plated layer and may still appear even if the coating meets the required specification.

Simply put, black spotting is a form of corrosion. They are localised areas of zinc corrosion and appear black due to the non-stoichiometic composition of excess zinc in the oxide deposit. This is in comparison to a typical white zinc corrosion on the external surface where the ZnO precipitated from solution is an even 1:1, and hence producing the white appearance.

These localised areas of zinc corrosion occur at the surface of the substrate beneath the plated layer. Hence the lack of oxygen and imbalance of zinc. The corrosion cells are formed in the natural cavities, cracks and pores of the material. In a similar way to the corrosion path of the external coating, propagating from the natural cracks are pores in the coating layer.

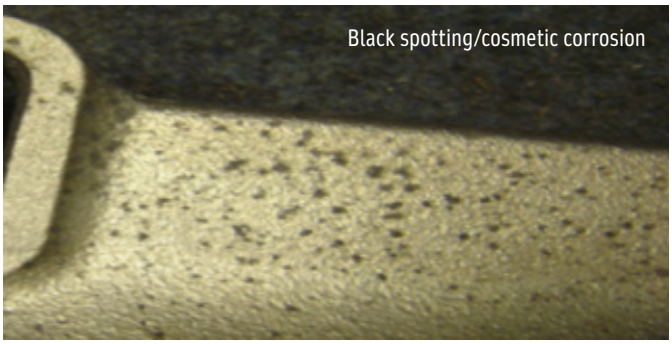
External corrosion is typically the focus of attention as its exposure to immediate degradation from moisture, handling, assembly etc dictates that it will usually corrode significantly quicker. Yet all materials have flaws and a degree of porosity that will lead to a natural corrosion progression from the substrate and hence formation of black spots. However, in the vast majority of cases the cracks and pores in the material are so minute that the black spots are never visible to the naked eye and if they do later appear it is often masked by the then onset of the expected white corrosion from the plating surface.

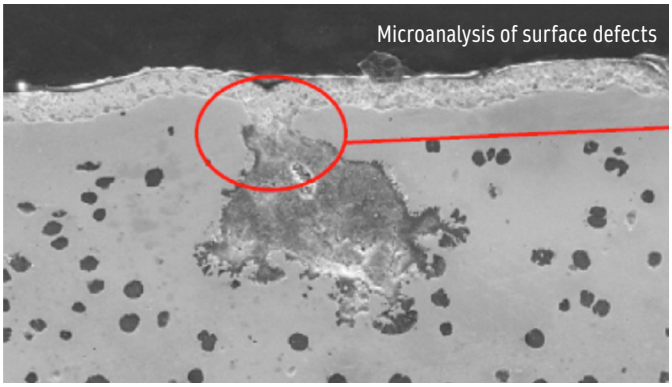
As black spots are considered a normal occurrence within the corrosion pattern, and occur independently of the plated layer, when they do become visible it is often referred to as cosmetic corrosion. This description accurately describes the presence of unsightly corrosion product but separates it from the corrosion protection functionally still provided by the coating from external factors.

Black spotting becomes a problem when their early appearance becomes visible to the naked eye. Again, often in the absence of any other corrosion formation to the external surface which makes it very obvious and unexpected. This is caused by a rapid acceleration of the localised corrosion cells between the metal and the plated layer. This is often, but not always, related to more significant and more numerous material defects where the larger cavities and pores allow the entrapment of plating solutions. Good examples of higher risk materials are cast iron, high carbon steels and sintered metals.

Even with the presence of potential mechanisms for black spotting to occur it still often requires additional external influence in order to propagate to a visual concern. Without the right environment and conditions black spotting cells can lay visually dormant. The biggest influencing factor is humidity, where the increased moisture and temperature mobilises activity under the plating layer, rapidly accelerating development. As such, conditions for transport and storage after electroplating are critical considerations.

There are risk mitigating techniques that can be employed throughout the process to help reduce the risk. These can include, material selection, machining methods, specially adapted pre-treatments and auxiliary processes but most of these will never provide a guaranteed fix. In best practice, impregnation prior to electroplating is a worthy consideration on high risk product as the process seals the material porosity, eliminating the risk of entrapment and minimising corrosion cell formation.


Black spotting/cosmetic corrosion


Microanalysis of surface defects

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