Advice & Counsel

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Taking A Powder

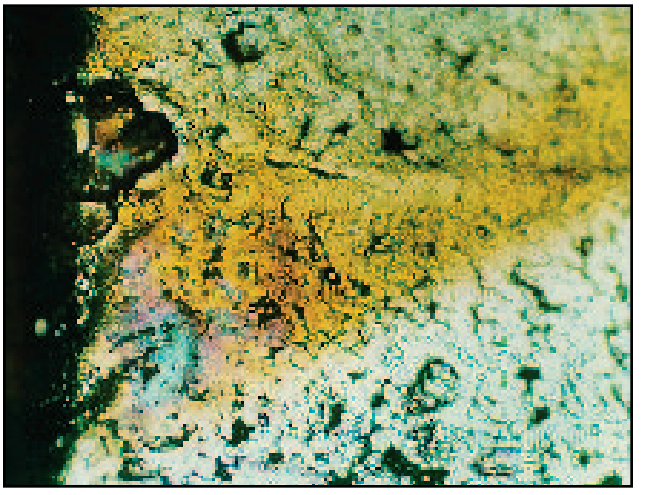
Dear Advice and Counsel,
We have been electroless-nickel-plating some stainless steel powder metallurgy parts for some time, but recently have experienced failure to pass a corrosion-resistance test. The test involves boiling the parts in deionized water for one hour. Following the boil, these parts have a satisfactory appearance in all areas except at one or more notches on the exterior diameter. The failure consists of a stain that is very localized. Can you help us find out why these parts fail?

Signed,
T. A. Powder

Dear T. A.,
We examined a cross section of these parts (photo 1 shows the parts, as received). The stained area of each sample was examined and photographed at 100X. The same area and a similar area on an unplated sample were then cross-sectioned and examined microscopically at 400X.

This part has been electroless nickel plated and has a stain on the right side of the notched area (after one-hr boil in deionized water). Part on right is unplated sample submitted along with the plated sample.

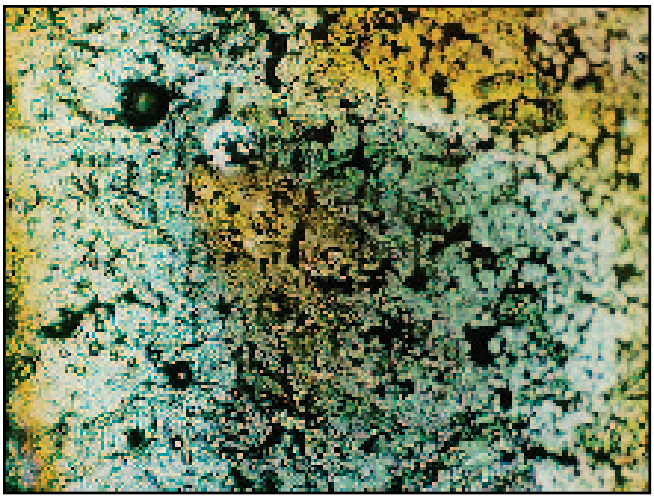
The stain is formed as a result of corrosion that occurs at sites where the powder metallurgy has not been adequately sintered, and evidences a severe amount of porosity, in comparison to areas that do not evidence the staining. The electroless nickel plates down—deep into the surface cavity—but as thickness builds and the plating on the sides of the cavity meet, a microscopic pore or tunnel is formed, which produces a "fissure" that travels down to the base metal (see photos).



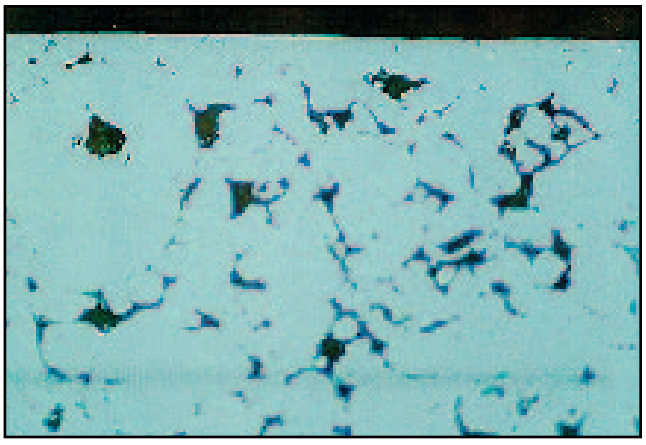
100X surface photo of stain on electroless nickel plated part, showing presence of large surface pores on left edge that may be source of stain following corrosion-resistance testing.

The stain cannot be eliminated by additional plating thickness, because, as the cross section illustrates, the fissure is formed by the EN deposit meeting from the rim of a surface pore that is large.

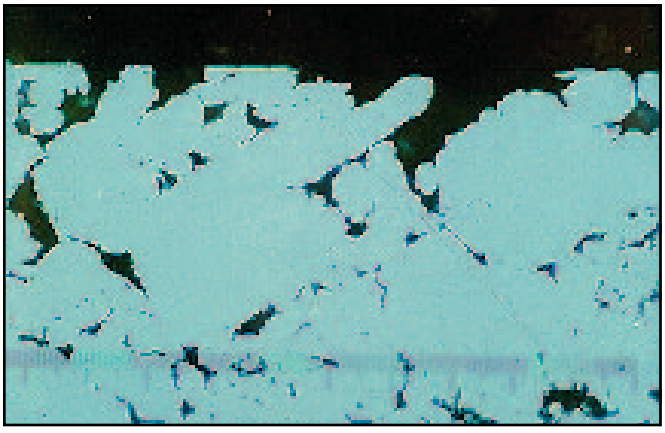
Powder metallurgy must be adequately impregnated, in order to fill the voids that are normally present after the sintering process. The unplated sample we cross sectioned, along with the plated sample, showed



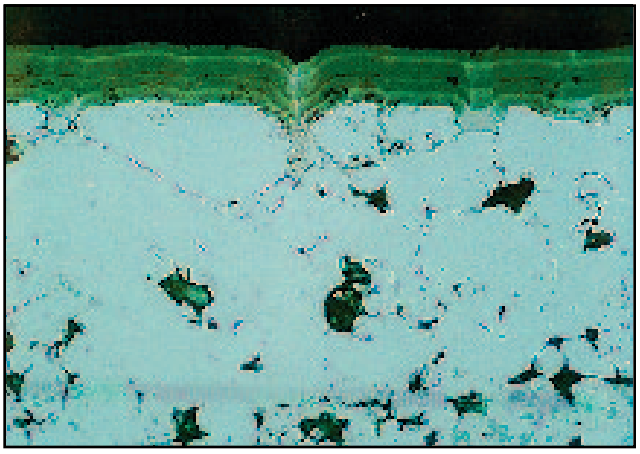
Second plated part (also 100X surface photo) evidencing stain in notched area. Note also that the individual powder spheres are clearly visible in this area, along with large surface pores.



This is a cross section (400X) of a notch in the area where staining was observed on the plated parts. Note the deep, large surface pores present, and the absence of any resin filling the pores, indicating poor impregnation of this area.



This is a cross section of a plated part in the area evidencing the stain (400X). Note the nickel plates deep into the surface cavity and, because all sides of the nickel meet in the center, a microscopic "tunnel" is formed by the intersection. This tunnel leads to corrosion test failures, and cannot be eliminated by more plating. The absence of impregnation resin is evidenced by the nickel depositing deep into the surface pores.



This is a cross section of the same unplated part in the photo above, in an area away from the notch (400X). Note that the surface is very smooth and relatively pore-free.

large surface pores in the area where staining was found after plating. These large surface pores did not contain any resin from an impregnation operation.

The sintering operation used to produce these parts needs to be improved, because it appears that the metal powder in the area evidencing staining is not adequately sintered. Our examination of the stain at 100X revealed a large amount of metal powder that remains in a spherical, unmelted condition, which we believe leads to the larger surface pores in this area. In areas where no individual metal powder spheres were visible, the surface of the part was dense and relatively free from large pores (see photos). P&SF