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SURFACE DEFECTS ON ANODIZED ALUMINUM ALLOY EXTRUSION

by

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PHYSICAL METALLURGY DIVISION

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SUMMARY OF RESULTS

Metallurgical examination of surface defects on an anodized aluminum alloy extrusion sample revealed these to be due to pitting attack, most probably produced during the anodizing process. Metal composition and structural quality were apparently not at fault but the actual cause of pitting could not be established.

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INTRODUCTION

Assistance was requested by Mr. R. Cunningham of Rusco Canada Limited, Scarborough, Ontario (letter of November 14, 1966) in determining the cause of surface defects, referred to as staining, on an anodized aluminum alloy extrusion sample. No details were given other than that a large quantity of material was similarly affected. A 6 in. sample length was received on November 21, 1966.

VISUAL EXAMINATION

The sample was a rectangular U-shaped architectural section with three internal ribs and a wide external flange on each leg. The surface defects occurred as individual spots of irregular shape frequently concentrated in randomly distributed colonies. All exterior surfaces, including both sides of the protruding flange, were affected in varying degrees with the greatest concentration being apparent on the outer side wall. A heavily spotted area on the latter is illustrated in Figure 1. On the interior surface of the extrusion, the end of each leg outermost from the rectangular rib, and the rib itself, also showed evidence of spotting. Except as hereafter noted, the remainder of the interior surface was unaffected.

METALLURGICAL EXAMINATION

Observation with a low-power binocular microscope revealed that the spotting visible to the naked eye was due to pitting attack of the surface. This was confirmed in metallographic examination of cross section specimens as illustrated by a typical microstructure along the outer surface in Figure 2. The rounded indentations and cavities varied in size, shape and depth and the maximum penetration found approached 0.0025 in. On adjacent areas, and within the shallower pits on the outer extrusion surface, the anodized layer was of a uniform thickness of about 0.00028 in. The layer was generally thinner on the interior walls at around 0.00017 in. and still thinner in the vicinity of the internal spherical-shaped ribs.

Microscopic examination of a stripped specimen further revealed a uniform scattering of shallow pits over the entire extrusion surface. This was in no way due to the coating stripping operation since the pitted nature of the surface was clearly apparent through the anodized layer in a taper microsection prepared.

The microstructure of the substrate metal in the several pieces examined was representative of a normal quality extrusion and there were no indications of any structural abnormality which may have contributed to the pitting attack. The alloying constituent distribution was uniform at and remote from the surface and this applied also to the recrystallized grain size revealed by prolonged etching of the polished specimens. As illustrated in Figure 2, no evidence of intergranular penetration was apparent at the base of the heavily pitted areas.

The chemical composition of drillings from the sample (anodized layer stripped) was found to be as given below in Table 1. It can be seen that the material conformed to Alcan 50S alloy (Canadian Standards Association Specification HA.5.GS10).

TABLE 1

Chemical Composition

	Cu, %	Fe, %	Si, %	Mg, %	Mn, %
Extrusion	0.03	0.25	0.51	0.54	0.01
CSA Spec. HA.5.GS10	0.10 max	0.50 max	0.20-0.60	0.45-0.85	0.10 max

The average hardness on the extrusion surface with the anodized layer removed was 73 Brinell (converted from Rockwell 30T readings). This corresponds to the accepted level of hardness for 50S alloy extrusions in the T5 temper (air quenched at die plus artificial aging).

DISCUSSION

The absence of any apparent composition or structural abnormality in the extrusion sample submitted suggests that the pitting effects were most probably produced during anodizing, presumably as a result of inadequate processing control at some stage in the pretreatment and/or coating process. Since no information on the operating conditions was given, it is difficult to speculate what factor or combination of factors was responsible. However, the nature and extent of the surface pitting, as well as the appreciable coating deposit in even the deepest holes, are synonymous with attack in the actual anodizing process. Inadequate control of the bath temperature at or near a constant level uniformly throughout the bath could account for such behaviour. Bath contamination by chloride drag-in is another well known source of pitting attack. In view of the good throwing power of the anodizing process, some degree of faulty bath operation was also suggested by the significant variation in thickness on the interior and exterior surfaces. In this connection, it is to be noted that the maximum coating thickness of 0.00028 in. found on the exterior surface is much less than the minimum thickness of 0.0008 in. recommended for architectural applications.

Although not of direct concern to surface appearance requirements, evidence of more gross pitting was also observed in the recessed corners adjacent to two of the internal spherical ribs. This took the form of a line of closely-spaced pinholes up to 0.015 in. in diameter which were covered by a black powdery deposit. These were oval-shaped in cross section with an irregular serrated boundary as shown in Figure 3. The location and gross size of the holes, in combination with yellowish stain deposits in the affected corners, is again suggestive of improper operation at some stage in the coating process.

CONCLUSIONS

The surface defects on the anodized extrusion sample submitted were found to be a form of pitting attack, most probably induced during the anodizing process. The extrusion composition and structural quality did not appear to be directly involved, but the actual cause of pitting could not be otherwise established because of the lack of information provided on

the anodizing processing conditions.

It is to be emphasized that the results and conclusions of this investigation are pertinent solely to the particular sample piece examined.

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Figure 1. Appearance of surface defects on exterior surface of extrusion, X 1-1/2.

Figure 2. Microstructure of pitted exterior surface. Etched in 0.5% HF, X500.

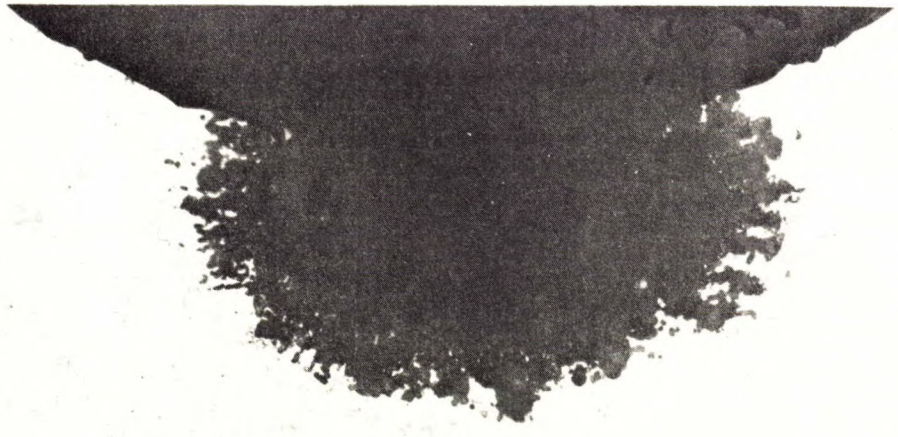

Figure 3. Microstructure of typical gross pit in recessed corner adjacent to internal spherical rib. Etched in 0.5% HF, X500.