Analysis and Testing of the Aluminium Anodising Process Pierce Levers

Aim of the Project

The Aim of the project is to analyse the process of Anodisation, select then apply the most suitable version to a large 5 Axis fixture in order to increase both its physical characteristics and aesthetic appeal.

Background

Anodisation is an electrolytic process in which current is passed through an acidic electrolyte and a part connected as the anode in the circuit which causes controlled growth of an oxide layer on the surface of the part that can be varied with current and time.

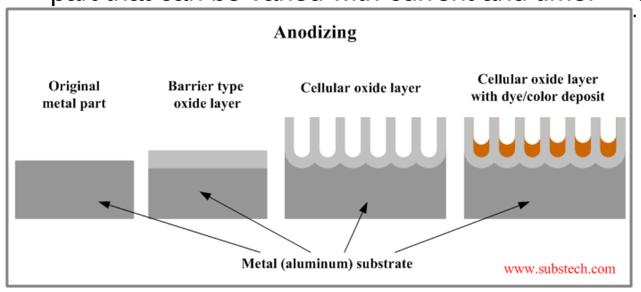

Figure 1: Anodising process Kopeliovich, (2023)

There are three main varieties of anodising used today, Type I which is primarily used as a layer to aid in paint adhesion due to its minimal thickness and protection, Type II which provides a balance of both corrosion resistance and added durability to your part while being able to accept dyes, and Type III which is an evolution of Type II which is purely focused on physical properties with a layer hardness exceeding that of stainless steel leading to its use in industrial applications. Regardless of which variant of anodization is chosen they all provide superior material properties compared to the base metal.

Benefits of Anodisation

Anodisation offers significant benefits when chosen as a finishing method for aluminium parts which range from massively increased wear properties and hardness with Type III anodized samples having a surface hardness of 400-500mV resulting in a wear resistance on par with some tool steels all while being a fraction of the weight, user customizability is also enhanced through anodizing as Type II and sometimes Type III coatings can be coloured through specific dyes allowing for products to be coloured for sale or to have fixture and components colour coded to aid in shortening setup times.

Photo of: Various colours of anodized keyrings.

Requirements for Anodising

The anodising process has multiple requirements to ensure that a uniform and strong layer forms One of these requirements is a clean surface with a smooth finish which will allow the oxide to grow uniformly without cracking or flaking which is likely around sharp edges. Another consideration is the fact that the whole part will be submerged and will require masking to prevent the growth of oxides on critical surfaces which may knock precision bores or threaded holes out of tolerance. Thankfully masking of these parts is relatively simple due to the versatility of masking compounds that can be painted on and removed with ease.

Testing and Verification

To test the effectiveness of the coating a test part was made that has similar features to the fixture being sharp corners, chamfered edges, bores and rounded surfaces which will allow for a good approximation of how wear will present itself on the fixture itself over time. The wear itself was simulated using a rotary rock tumbler and silicon carbide tumbling media.

Photo of: Test Part in tumbler setup.

An uncoated part and a coated part will be ran in this setup for 30 minutes each to simulate a large period of wear, then the parts will be compared to each other and an untested sample through various means to gauge how much damage has been prevented by the coating. Part of this will be done using the S.E.M which will allow for precise measurement of both surface finish and the depth of any scratches/gouges present.

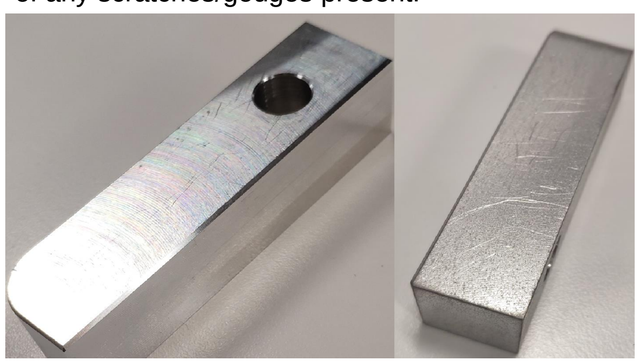

Photo of: Before and After tumbling for 30 minutes to simulate wear.

To ensure that the fixture itself has not had critical dimensions thrown out of specification by the anodising process, all critical dimensions will be checked by a CMM and compared to a measurement of the same part taken prior to coating.

Conclusion

Aluminium is a common material that when used with proper consideration can be just as if not more versatile than steel, however it has some drawbacks when it comes to physical properties. These drawbacks of insufficient hardness and susceptibility to corrosion can be almost entirely sidestepped through the use of a proper surface treatment such as Type II or preferably Type III anodising, resulting in a fixture as reliable and sturdy as one made of steel at almost a third the weight thanks to Aluminium's lower density. The potential issues of anodising such as coating in unintended areas or over exposure can be avoided through proper setup which results in a process that is near perfectly suited to this use case which can be seen across the market for large fixtures.

References

1.Kopeliovich, D., 2023. Anodizing. [Online] Availableat: https://www.substech.com/dokuwiki/doku.php?id=anodizing

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