Adding Color to the Olympic Torch: Anodized Aluminum Provides Vibrant Blue For the Sydney 2000 Olympic Torch

Since 1936, when it was first introduced, the Olympic torch has been a distinctive symbol of the Olympic Games. For a period of 11 days and nights, more than 3,000 torchbearers each carried the Olympic flame for one kilometer, from Ancient Olympia on the northwest Peloponnesus peninsula in southern Greece—the site of the original Olympic Games—to Berlin, where the XI Olympics were to take place. The Olympic Torch Relay for Sydney 2000 last month was the longest in the history of the Olympic games. After the lighting ceremony in Olympia, the torch traveled through 13 Oceanic nations before arriving in Australia, where it was carried by more than 11,000 torchbearers on a 27,000-kilometer journey throughout Australia.

Keeping the Olympic flame continuously lit during the entire journey has always been a technical challenge. For the Sydney 2000 Olympic games, a new torch was developed. Bearing some resemblance to the Australian boomerang, it has a uniquely Australian design. It consists of three layers, each representing an element of nature: earth, fire and water.

Vibrant Blue Color Through Anodized Aluminum

What the designers of the new Olympic torch had in mind was the right shade of blue that is associated with the color of the Pacific Ocean. The technical answer was to use anodized aluminum in the middle, blue layer of the torch, which contains the fuel canister. Although the metal underwent surface treatment, the metallic shine of the aluminum could be preserved.

A specialist Australian company, Anodizers and Electroplaters, searched for and chose a proprietary liquid* for this extra-special job. The result was a deep and vibrant blue—as deep and vibrant as the color of the sea.

Special Dyeing Process

The chemical and technical requirements for the Olympic torch were rather tough, but all were met. Anodized aluminum is very resistant, due to a special process. First, a microporous oxide layer is produced in an anodic oxidation process. In acid solution, the following reactions take place:

Anode (Aluminum)

Oxidation: $2Al^{3+} + 6e^-$

Surface Oxidation: Al_2O_3

10-20 % H_2SO_4

Cathode (Steel/Carbon)

Reduction

$2H^+ + 2e^- \rightarrow H_2$

The aluminum oxide layer has a minimum thickness of 20 µm, consisting of numerous hexagonal cells oriented vertically to the metal surface. Each cell encloses one pore. There are about 10^{10} pores per square centimeter surface, each with a diameter of c. 100 Å and a length of several 100,000 Å. Because of this special structure, the oxide layer is able to adsorb substances more easily.

This surface is the basis for the dyeing of the aluminum. Organic color molecules are inserted into the aluminum oxide layer. The color for the torch is a copper phthalocyanine complex.

After the dyeing process, the pores are sealed. In a few minutes, through hydrolysis at higher temperature, nickel salts form a plug-like pore sealant, consisting of aluminum-nickel mixed oxide hydrates. These "plugs" go about 3 µm inside the pore canals and prevent the adsorbed dye from leaking.

Resistant to Tough Weather

As the colored layer is intrinsically linked with the metal, it adds to the hardness of the metal and to its abrasion resistance, making it perfectly prepared to withstand even the toughest climate. The colored oxide layer is transparent, so that the metallic character and the original shine are not affected, and the vibrant blue color is preserved.

Not only the vibrancy of the color, but also the excellent light and weather fastness of the liquid were decisive factors when choosing this product. There was no doubt that the torch would be subjected to a variety of very extreme conditions, and to whatever weather Australia would provide during the longest torch relay in the history of the Olympics. The torch was carried through 1,000 towns and suburbs, from humid rain forests to the most arid areas. One highlight was the first underwater trip for the torch, when deep-sea divers took the flame into the Pacific Ocean.

To ensure that the torch was able to withstand the most severe conditions, it was tested to stay alight in winds up to 65 kilometers per hour, as well as in tropical downpours. It went through every test as brilliant and shining as before. P&SF

**Sanodal Turquoise Blue PLW liquid, Clariant Corp., Basel, Switzerland.*

Out of This World

Clariant Corporation is a leading global manufacturer of specialty chemicals, whose products have gained an excellent reputation internationally. It has more than 100 group companies operating on five continents. The color to dye the anodized aluminum for the Sydney 2000 Olympic torch was supplied by Clariant's BL Special Fields Group in Basel, Switzerland.

But the company is not only represented on earth. It also left traces in outer space when Neil Armstrong made his historic moon walk in 1969. The commemorative plaque he erected on the moon had been treated with a Clariant product.