Slot Die Material Innovations: Tungsten Carbide

N. Rikita, M. Yasutake
R&D Marketing Division, MMC Ryotec
1528, Yokoi Nakashinden, Godo-Cho, Anpachi-gun,
Gifu-Pref., 5022301, Japan

Presented at the 16th International Coating Science and Technology Symposium,
September 9-12, 2012, Midtown Atlanta, GA[1]

Currently there are several processes available for wet-coating. Among these methods, slot die coating is one of the most well-known. In recent years slot die coating has been utilized in many emergent technologies from solar PV to li-ion battery. As technologies continue to advance we will see more complicated slurries with decreased cross web uniformity requirements, demanding more from slot die design. In many cases a stainless steel slot die can address manufacturing needs; however, the continued innovation of coated products will demand increasingly precise performance. In order to manufacture a slot die for these instances MMC Ryotec (MMCR), a subsidiary of Mitsubishi Materials, developed slot dies featuring tungsten carbide lips. The application of tungsten carbide in slot die lip construction is a relatively young concept in North America. However, it has roots in Japan since 1981 when first introduced for magnetic tape applications. The inherent qualities of the material, such as grain size, hardness, and corrosion resistance, lend it well to a variety of

[1] Unpublished. ISCST shall not be responsible for statements or opinions contained in papers or printed in its publications.

coating applications in contrast to traditional stainless steel.

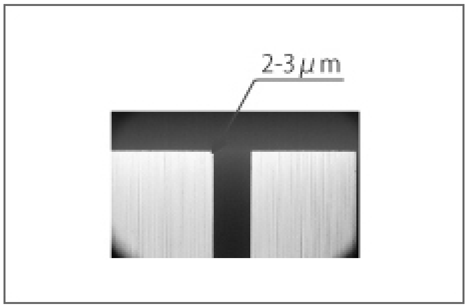
In the development of tungsten carbide lip slot dies, the below issues with stainless steel slot dies were considered.

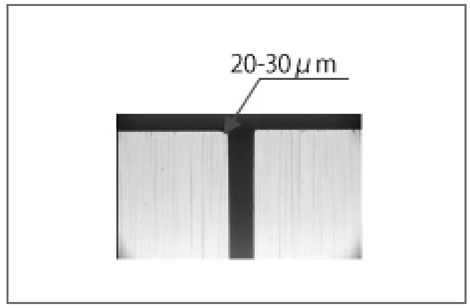
- Consistent pinning on the edge of lip
- Corrosion of the slot die lips
- Inaccurate start and stop edges of intermittent coating
- Sharpness of coating edge
- Flatness uniformity of the lip

The use of tungsten carbide helps alleviate the aforementioned concerns through the material characteristics of the compound. Carbide is manufactured by carbonizing tungsten and carbon powders and adding a binder, primarily cobalt. This mixture is then pressed into its necessary form and sintered into the final product.

A characteristic of tungsten carbide that contributes to coating consistency is the grain size of the material. Tungsten carbide is produced with a submicron grain structure of <0.9 µm, as a result of this, surface finish and corner radius can be held to tolerances under Rz 0.2µm and 2 – 3µm, respectively. Below (Example 1) is a comparison of the corner radii ranges between tungsten carbide and stainless steel.

Example 1





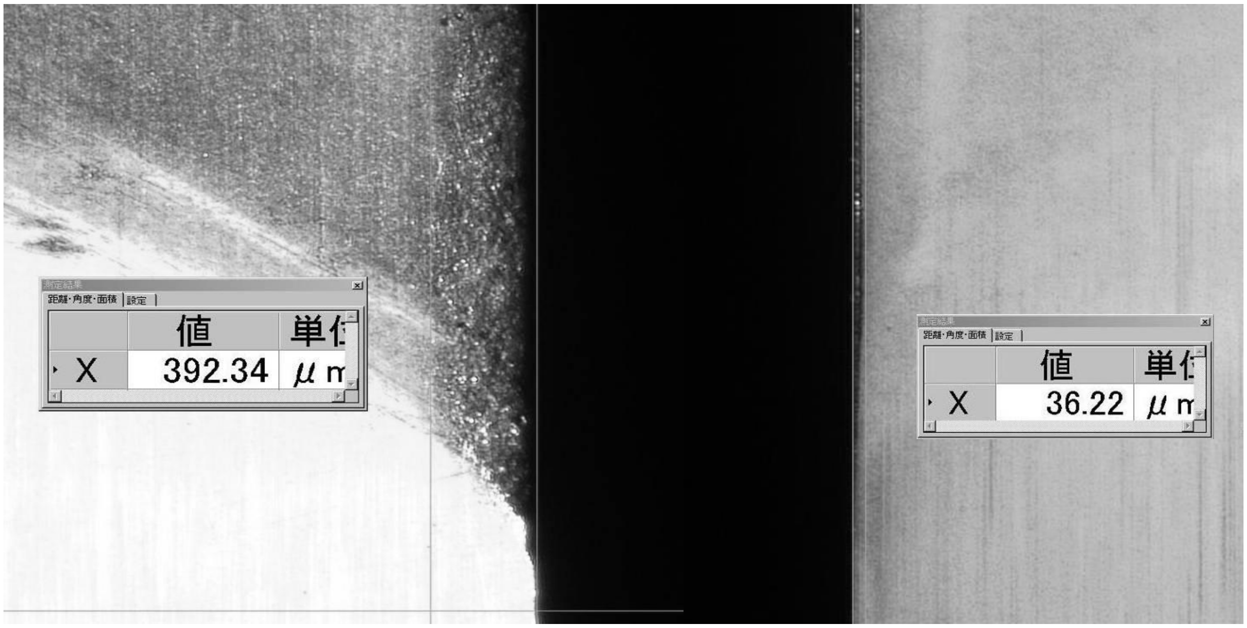
Lip Edge of Tungsten Carbide

Lip Edge of Stainless Steel

The tight corner radii and surface finish improve flatness tolerances, improving slurry flow accuracy and pressure reduction at the lips. With heightened control, more consistent pinning of the coating bead is attainable, leading to improved start and stop edges of intermittent coating.

Tungsten carbide is widely used in a number of industrial manufacturing applications due to its wear resistant properties. The cutting tools industry has used tungsten carbide since the 1930’s to increase tool life 5 – 10 times over stainless steel counterparts. It is the uniform makeup of the material coupled with high hardness ranging from 70.0 to 94.0 HRA that is integral to its wear resistance qualities. Below (Example 2) shows the wear of a stainless steel lip compared to the tungsten carbide lip. The wear of both lips is measured after pilot-production of li-ion battery electrodes for a period of three years. Conclusively, the high abrasion resistance of tungsten carbide is approximately 10 times greater, reducing the need for regrinds.

Example 2



【SUS Upper Lip】 【WC Upper Lip】

These attributes of the tungsten carbide reinforce the applicability to slot die coating. Products that adhere to strict coating uniformities and operators demanding longer slot die life can benefit from a tungsten carbide lipped slot die. The innovation of the tungsten carbide lipped slot die addresses growing demands for refinement that is critical to industries reliant on a coating device with improved corrosion resistance and coating precision.