New Ceramic Coating Reduces Static Buildup, Ensures Quality Control in Electronics Applications

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When it comes to the assembly and manufacture of today’s complex electronic devices, consistent production methods are a must. Pick and place machinery is expected to perform flawlessly to keep wafers and electronic assemblies intact during each manufacturing step. Special coatings are often used to protect this equipment from wear and abrasion. However, static buildup can occur on metal parts due to the highly insulating nature of many of these coatings, leading to damaged electrical components. To solve this problem, General Magnaplate Corporation has developed a new conductive nano engineered coating formula that guarantees a precise and consistent level of surface resistance (10⁶ to 10⁹ ohms/cm) to dissipate troublesome static charges and keep electronics applications flowing smoothly.

Trouble with Traditional Coatings
Much of the equipment used in today’s high-speed manufacturing environments is made of aluminum because it is plentiful, lightweight and inexpensive. Anodization coating processes are often used to fortify these aluminum parts, imparting a hard and wear resistant aluminum oxide (Al₂O₃) layer to the surface. Although this process is suitable for many applications, it can lead to problems when working with sensitive electronic components and devices, such as silicon wafers, light emitting diodes (LEDs) and medical instruments. Why? Traditional anodization creates a surface that is highly insulative and therefore non-conductive. In fact, the electrical resistivity of a typical anodized aluminum surface ranges from 10¹⁰ to 10¹⁵ ohms/cm, which allows formation of
static buildup that cannot bleed off through the insulative surface. This static buildup is precisely what can lead to damaged electrical components and, ultimately, defective devices.

At the other end of the spectrum, aluminum by itself or treated with a conductive coating such as a nickel-based formula is overly conductive and will cause electronic circuits to short. To achieve the ideal balance between conductivity and resistivity, thereby reducing static buildup while providing the necessary conductivity, the part surface should fall between $10^6$ and $10^9$ ohms/cm.

Recently, a semiconductor manufacturer faced this very issue and needed to dissipate the static charges being generated on pick and place trays employed in its production areas. The company was using a polymer-based coating to provide the correct ohm reading on part surfaces, but it was wearing off quickly. Due to the coating’s limited wear life, the manufacturer was experiencing frequent work stoppages in order to recoat trays, as well as consistency issues regarding chip testing. The engineering team was familiar with General Magnaplate’s reputation as a coating expert, and approached them to see if they offered an alternative coating formula that would solve these problems. Although General Magnaplate did not offer this type of coating as an off-the-shelf formula at the time, their R&D team set to work developing just such a product.

A New Coating is Born
Researchers at General Magnaplate began to develop an electronics-friendly coating formula by using their popular TUFRAM® coating for aluminum and aluminum alloys as a starting point. Utilizing a multi-step process that makes aluminum surfaces harder than steel, TUFRAM coatings combine the hardness of aluminum oxide ceramic with desirable properties of various Magnaplate materials. The result is aluminum parts with previously unattainable levels of hardness, wear and corrosion resistance, and permanent lubricity. Because the newly coated surface is superior to both the aluminum and any individual components used in the process, these coatings are said to be “synergistic”. Further, because the TUFRAM coating becomes an integral part of the base metal, it will not chip, peel or flake off like traditional spray-on coatings.

The next step in developing the new coating with the specific ohm range required by the semiconductor application (between $10^6$ and $10^9$ ohms/cm) was to select the correct materials to infuse into the TUFRAM surface. After experimenting with several additives of various types and in different quantities, the team arrived at using a proprietary
nanoparticle to achieve the desired electrical resistance. By adding this nanoparticle to the proven TUFRAM coating, a new formula was born. TUFRAM Omega® features a powerful combination of properties — harder-than-steel abrasion resistance and a precise range of electrical resistance — for use in the electronics industry and many other applications.

Applications Abound for TUFRAM Omega

The newly developed TUFRAM Omega coating formula strikes a perfect balance between electrical resistivity and conductivity, useful in many electronics applications where a precise level of electrical surface resistance is desired for aluminum parts:

• Semiconductor manufacturing
• LED manufacturing
• Solar cell manufacturing
• Electronic component and device manufacturing
• Aluminum rollers and slide carriers
• Pick and place equipment
• Medical electronic instruments
• Telephone exchange equipment
• Automated handling equipment
• Exterior surfaces of spacecraft
• Commercial satellites

Testing Results Verify TUFRAM Omega Properties

When engineered coatings are created, a vital step in the development process involves testing and verification by an independent laboratory. To confirm the wear resistance properties of TUFRAM Omega, taber abrasion testing was performed in accordance with ASTM D4060 using a 1,000g load and CS-17 wheels. Weight loss was recorded after every 1,000, 5,000 and 10,000 cycles. An electron microscope was then used to check if conductive material was still present in the pores of the abraded area. After 20,000 cycles, the conductive coating material indeed remained in the pores, meaning that the TUFRAM Omega coating experienced very little wear and is a truly synergistic coating that becomes an integral part of the aluminum substrate.

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<th>Number of Taber Cycles</th>
<th>Weight Loss (mg)</th>
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<tr>
<td>1000 cycles</td>
<td>5 mg</td>
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<tr>
<td>4000 cycles</td>
<td>6.5 mg</td>
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<td>5000 cycles</td>
<td>4.5 mg</td>
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<td><strong>Weight Loss</strong> = 16 mg/10,000 cycles</td>
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To verify surface resistance, testing was done in accordance with ANSI/ESD STM 11.11-2006, which measures surface resistance in ohms. Measurements were made using a Prostat PRS-801 Resistance System. Based on surface resistance results, the testing lab confirms that TUFRAM Omega is a dissipative material with surface resistance between $10^6$ and $10^9$ ohms/cm, sufficient to dissipate static charges.

Since applying TUFRAM Omega to its aluminum rollers, the semiconductor manufacturer has eliminated the problem of static buildup interfering with chip production. The new coating is now available as an off-the-shelf formula and is being used in several different applications and industries.

To learn more about TUFRAM Omega and other problem-solving surface enhancement coatings, contact technical representatives at General Magnaplate Corporation, call (800) 852-3301, e-mail info@magnaplate.com, or visit www.magnaplate.com.