High-Performance Composite Powders for Electronic Devices

BRIAN CALLEN
SULZER METCO

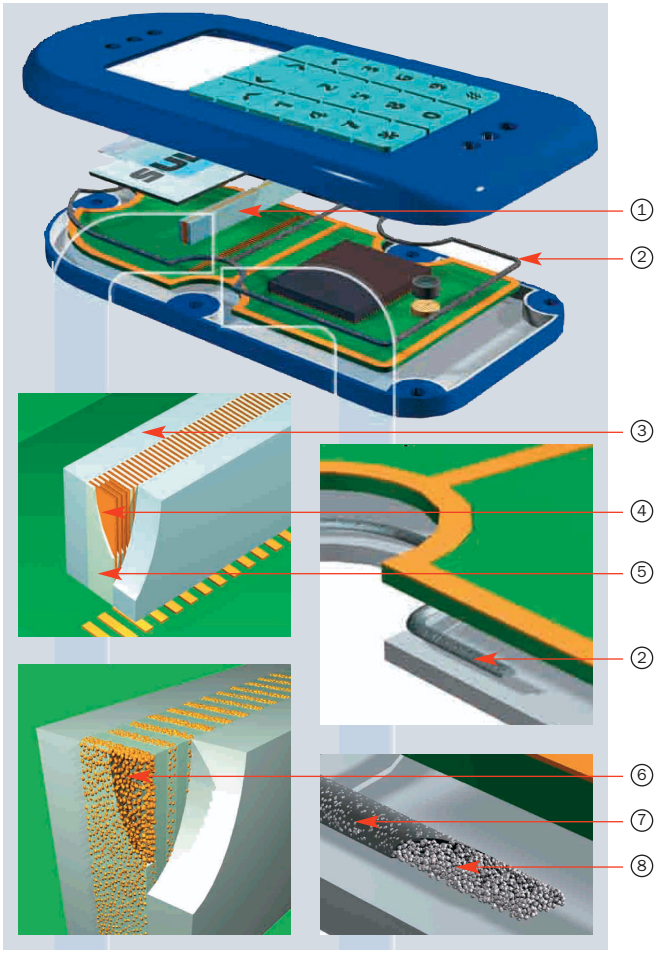
It has become increasingly necessary for mobile telephones, computers, medical apparatuses and airplane electronics to be protected from disturbances by electromagnetic fields. Sulzer Metco has made significant contributions toward ensuring this protection through the development of specialized composite powders.

Nickel-clad graphite powders are a well established composite material in gas turbines, where they are used as abradable seal coatings and applied by thermal spray technology. In the last decade, however, newer applications for nickel graphite have arisen in electronics applications. Here, they are used as conductive fillers in electronic components such as switches, connectors, and shielding materials. The shielding materials are designed to protect devices such as cellular phones, computers, medical devices and aircraft electronics from electromagnetic interference (EMI). Sulzer Metco (Canada)'s E-FILL™ conductive fillers, including nickel graphite and gold-nickel graphite powders, address the continuously changing high-performance requirements and demand for lower costs of the electronics industry.

Protection Against Electromagnetic Interference

Many electronic devices emit radio and microwave noise that can interfere with other devices. Interference associated with wireless communication devices spans the electromagnetic spectrum from lower-frequency radio and television signal bands up to higher frequency

1 The inside of a cellular-phone casing showing a perimeter conductive gasket for EMI shielding (upper and lower right) and a z-axis connector to attach the display to the board (upper and lower left). Details show how the conductive particles are in contact with each other to form a continuous electrical circuit.



① Z-axis display connector
② Nickel-graphite-filled EMI-shielding gasket
③ Silicone support (non-conductive) for z-axis connector
④ Conductive layer in z-axis connector
⑤ Silicone insulating layer in z-axis connector
⑥ Gold-coated nickel graphite particles in z-axis connector
⑦ Gasket composed of silicone rubber with nickel graphite filler
⑧ Nickel graphite particles within gasket

bands (>10^9 Hz) used for cordless phones and cellular phones.

Manufacturers are regulated by standards that set limits on how much EMI a particular device is allowed to leak into the environment. Common electronic devices such as cellular phones, computers and medical instruments use metal or metal-plated enclosures to shield components from EMI. All gaps must be sealed from leakage, and this is commonly accomplished with conductive gaskets, which block EMI through a combination of absorption and reflection of the EMI waves. Cellular phone casings, for example, are metal-plated on the inside and sealed with such conductive gaskets (Fig. 1). The conductive gaskets often have an additional function to protect components from outside moisture and dirt. The gaskets are produced from synthetic rubbers, such as silicone, and are filled with metal-based powders to make them electrically conductive.

Nickel Graphite for Shielding: Lightweight and Corrosion-Resistant

Composite powders such as silver-coated glass or nickel-coated graphite are common fillers because they are lightweight and less expensive than pure-metal fillers. Nickel graphite offers the synergistic properties of reflection by the nickel cladding and absorption by the graphite core; it thereby provides excellent shielding properties similar to higher cost silver-based powders. Unlike silver, nickel graphite is less susceptible to the corrosion induced by sulfurous environments such as those in industrial areas.

E-FILL nickel graphite is available in average particle size ranges from approximately 30–120 microns. The nickel cladding covers the whole surface of each graphite particle and has a stable, oxide-free surface. The nickel content typically ranges from 60 to 95% by weight depending on particle size. The particles are rough and irregular in shape to provide good particle-to-particle electrical contact and allow the gasket to "bite" into the conductive mating surface (Fig. 2).

Achieving the Right Level of Shielding

The gasket's physical and electrical properties are greatly affected by the powder's particle size, shape, surface roughness, and surface chemical properties. Customers may choose the grade of E-FILL nickel graphite best suited for the type of gasket they are producing. For example, a very thin gasket, less than 1 mm, would require conductive filler with a relatively small particle size.

EMI gasket materials must provide sufficient shielding perform-

Z-Axis Connector

Z-axis connectors (Fig. 1) connect finely pitched contacts on the backs of display panels to matching contacts on printed circuit boards. The rubber connector consists of very finely pitched alternating conductive and non-conductive segments, which have a finer pitch than the contacts on the display and circuit board. When the z-axis connector is pressed between the display and board, the conductive segments form and direct the electrical connections between matching contact spots. These conductive segments typically use gold coated conductive fillers.

ance while satisfying application-specific requirements such as gasket hardness, strength and elasticity. Shielding performance is directly associated with conductivity of the filler. Fillers with small particle size are harder to work with than coarser fillers, because the larger surface area tends to absorb the rubber to a greater extent. There is a delicate balance between using too little and too much conductive filler: Loading the rubber with too much filler results in the gasket being too hard, brittle, or difficult to mix in the fabrication process. Acceptable physical and shielding properties are achieved by using about 60–65% conductive filler by weight of the gasket (typical tolerance window <2%).

Gold Nickel Graphite: High Conductivity and Stability

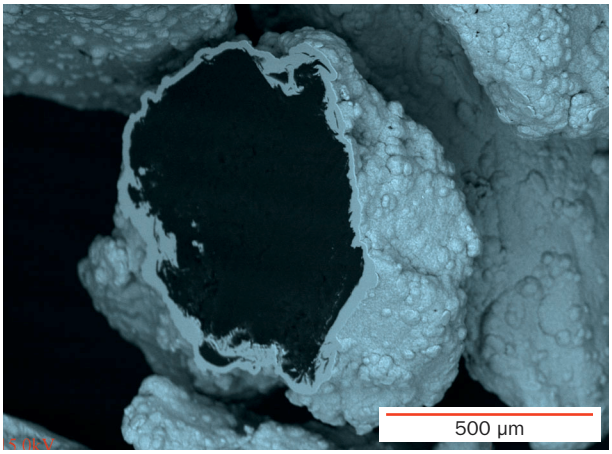
Numerous applications in electronics require fillers with high conductivity and stability, which can only be achieved with gold. Electronic components in cellular phones, such as keypads, microphone connectors and z-axis connectors for displays, use gold conductive fillers.

E-FILL gold-coated nickel graphite is a cost-effective alternative to pure gold powder because much less gold is used. Nickel graphite as a substrate for gold coatings offers a hardness, roughness, and irregular shape that work well for conductive fillers in general. A relatively small amount of gold greatly increases the conductivity of the powder. A very thin layer of gold is all that is required to provide each particle with a highly conductive contact surface. The gold has the additional benefit of environmental stability, since it does not oxidize. The addition of 1% gold by weight to E-FILL nickel graphite power (30 micron) increases the conductivity from 0.00005 $(\Omega \bullet cm)^{-1}$ to 640 $(\Omega \bullet cm)^{-1}$ —a factor of over ten million (Fig. 3).

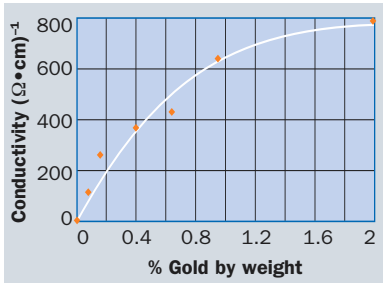
Powders with smaller particle sizes require more gold to achieve the same effect because they have a larger surface area. The amount of gold required also depends on particle roughness and shape. Fine-pitched applications such as z-axis connectors require relatively small particles, typically 30 microns or less.

New Materials

The evolution and manufacturing of electronic devices call for the continuous development of new conductive fillers. Sulzer Metco (Canada) continues to develop complementary new composite powders for shielding and conductivity applications with finer particle size, new shapes, and new materials. ◀



2 Cross section of nickel graphite particle showing nickel cladding ~3 microns thick, coated on a graphite particle ~80 microns in size.



3 Addition of a gold coating to 30 micron E-FILL nickel graphite powder causes a rapid increase in conductivity. In this case, a maximum is attained at ~2% gold by weight powder.

CONTACT

Sulzer Metco (Canada) Inc.
Brian Callen
10108-114 Street
Fort Saskatchewan
Alberta, T8L 4R1
Canada
Phone +1(1) 780 992 5154
Fax +1(1) 780 992 5120
brian.callen@sulzer.com