Abstract #205, 224th ECS Meeting, © 2013 The Electrochemical Society

The Conductivities of Electrically Conductive Adhesives Containing Silver-Coated Graphite Particles by Self-Activated Deposition

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Polymer-based conductive-adhesive materials have become extensively utilized in many applications including electronic packaging interconnects. Electrically conductive adhesives (ECAs) have acquired prestige as a potential replacement for solder interconnects. They not only provide a ‘lead-free’, ‘no clean’ alternative to solder; these highly compatible materials also offer viable answers to problems where solder is totally deficient. Other advantages such as lowered process temperature, increased metallization options, reduced thickness, decreased cost and equipment needs. The ECAs principally comprise an organic/polymeric binder matrices and conductive fillers. The conductive fillers furnish the ECAs with excellently electrical properties and the polymeric matrices provide the mechanical and physical properties. Meanwhile, it is very important to select the suitable materials for conductive particles. Nickel (Ni), copper (Cu), gold (Au), and silver (Ag) are by far commonly used conductive fillers for electrically conductive adhesives, and silver is totally unique among the affordable metals for its high conductivity of the oxide after exposure to heat and humidity. Besides, silver particles are easy to form and to fabricate into ideal shapes. This means that accurately the right sizes of particles can be produced for use as is, or for milling into fine flakes. However, from the aspect of its high prices, silver content may be lowered down for its applications in conductive adhesives. To overcome this, many improved methods are adopted. Metallization of graphite surface is one way deemed to be an effective approach to endow graphite with excellent metallic thermal and electrical conductivity and reduces the silver content of conductive fillers. Up to now, many methods have been adopted for surface metallization of materials, including electrophoretic deposition [1], electrodeposition [2], and chemical vapor deposition [3]. These techniques require either special equipment or complicated process control. Electroless deposition [4, 5] provides a highly effective but simple and advantageous method for industrial production, such as low-cost, uniform thickness, and low coating rate, etc [6].

The preparation of silver-coated graphite involved an initial pretreatment of the graphite, i.e. by conventional two-step sensitization–activation and a subsequent reduction of $AgNO_3$ in the presence of glucose solution. Herein, a novel silver self-activated electroless deposition on graphite designed as conductive filler were employed, and a uniform silver coating with minimal agglomeration on graphite surface was obtained.

The morphology of the silver-coated graphite was studied by scanning electronic microscopy (SEM), as shown in Figure 1. The characterization of the silver-coated graphite particles by XRD and EDS spectroscopies were studied in detail.

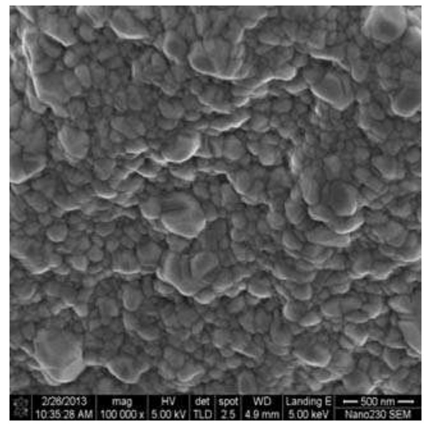

Figure 1. SEM images of silver-coated graphite via silver self-activated electroless deposition.

Furthermore, the electrical resistivity of electrical conductive adhesives (ECAs) containing silver-plated graphite powders have been investigated in this study for reducing the silver amount in conductive adhesives. The best result of the electrical resistivity of epoxy-based conductive adhesives obtained is 5.16×10^{-4} Ω-cm for 60 wt% of silver-plated graphite powders. The weight percentage of silver in this epoxy-based adhesive is reduced to 56.61 wt%, which is much less than that of the regular commercial silver conductive adhesives.

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