21st International Conference on

Advanced Energy Materials and Research

July 11-12, 2019 | Zurich, Switzerland

Architecture and interface design for ultrahigh conductivity of graphene/copper composites

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Achieving electrical conductivity to a level higher than the ultra-high conductivity of the internationally annealed copper standard (100% IACS) is the development required for copper based conductor materials for cutting-edge manufacturing and high-tech advancement. At present, the conventional refining and single-crystallization methods for improving the conductivity of metals are close to the physical limit, and the limited conductivity of materials also requires a high cost. The composite route of introducing high conductivity enhancer into the metal matrix is one of the effective ways to overcome the physical bottleneck of the conductor preparation and realize the ultra-high conductivity of the material. However, in practical preparation, it still faces the difficulty of purifying high-conductivity metallic carbon nanotubes and the difficulty of high-order ordered dispersion in metal matrix, which hinders the stable realization of ultra-high conductivity and the macro-preparation of composite materials. Graphene with a two-dimensional carbon atom structure is considered to be an excellent conductor material due to its natural zero-bandgap metallic character and ultra-high electron mobility. At present, chemical vapor deposition (CVD) has enabled large-scale preparation of graphene with high conductivity. Unlike one-dimensional carbon nanotubes, CVD graphene can be grown in situ directly on the surface of a copper substrate to form a graphene/copper heterostructure composite. The composite units are then assembled and densified. The highly oriented dispersion arrangement of graphene inside the composite material can be realized and the in-plane high conductivity property can be maximized. Our research proposed a bottom-up graphene/metal composite material preparation technology to achieve the orderly embedding of high quality graphene in a metal matrix. As a result of ultrahigh electrical conductivity of graphene (3000 times higher than copper) and corresponding graphene/metal composites (117% IACS) were obtained and the conductive mechanism were also understood by designs on architecture and interface.

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