

In situ fabrication of graphene from a copper–carbon nanoneedle and its electrical properties

ABSTRACT

Herein, we present a direct observation of the formation of graphene from a single copper–carbon nanoneedle (Cu–CNN) during the measurement of current–voltage (I–V) and direct heating via in situ transmission electron microscopy (TEM). Significant structural transformation of Cu–CNN was observed with an applied potential in a two probe system. Under a high current flow between 4.9 μA to 49.0 μA , the Cu nanoparticles melted and evaporated due to Joule heating. The amorphous carbon began crystallizing and transformed into sp^2 hybridized hollow graphitic carbon, which was catalyzed by the dispersed Cu nanoparticles. The temperature generated during the current flow was estimated to be 1073 K, as revealed by an in situ TEM heating experiment. The graphene nanoneedle formed exhibited a high current density of 10^6 A cm^{-2} , which is comparable to Cu in normal interconnect applications. Thus, the graphene nanoneedle formed will be promising for future alternative interconnect materials.

Keyword: In situ fabrication; Graphene; Copper–carbon nanoneedle; Electrical properties