Mechanism of solid-state plasma-induced dewetting for formation of copper nanoparticles

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Cu nanoparticles were synthesized by plasma-induced dewetting. SEM and TEM images revealed that Ar plasma induced dewetting of Cu films proceeded through heterogeneous hole nucleation on the film surface. Holes were nucleated and grown along the grain boundaries to lower the surface energy until Cu nanoparticles were formed. The energy which was transferred to the atoms at the film surface by Ar ion was calculated to be 16.1 eV/ion, and it was sufficient for displacing Cu atoms. By plasma-induced dewetting, more uniform nanoparticles were obtained compared to thermal annealing process because a larger number of smaller holes were generated and the energy transferred to the substrate surface was uniform. In addition, the effects of plasma density and sheath potential on the dewetting process were investigated. It was found that high plasma energy, produced by high plasma density and high sheath potential, yielded uniform Cu nanoparticles, which were not obtained under a relatively low plasma energy condition.