A multi-step process to manipulate the size distribution of nanoparticles formed by ion implantation

V. Ramaswamy, T.E. Haynes, W.J. MoberlyChan, M.J. Aziz

The broad size distribution of nanoparticles formed by ion implantation is a current limitation of this synthesis technique. Precipitates of uniform size can be obtained, in principle, by an understanding and manipulation of the kinetics of nucleation, growth, and ripening, and of the associated irradiation effects. We have investigated the formation of nanoparticles of elements insoluble in SiO_2, such as Au, by multiple implantation steps and intermediate anneals in order to isolate nucleation and growth processes, thereby reducing the breadth of the size distribution. We have used cross-sectional TEM to compare samples implanted in multiple steps to samples implanted with the same dose in a single step. We discuss the effects of varying the initial nucleation dose and the growth temperature, and show that this methodology can be used to synthesize precipitates with improved size uniformity and spatial distribution.