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Application of microplasma to synthesis of silicon nanoparticles
KENJI SASAKI, Dept. of Mechanical and Control Enngineering, Tokyo Institute of Technology, TOMOHISA OGINO, DAISUKE ASAHI, TOMOHIRO NOZAKI, KEN OKAZAKI — We developed microplasma to synthesize nanocrystalline silicon particles (nc-Si). Gas residence time in micro plasma reactor is of the order of μs, while time required for particle nucleation by three-body collision? is about ms. Thus it is possible to separate crystal nucleation and growth in a single reactor. This process is very important for synthesis nc-Si. Microplasma was formed in a capillary tube of diameter 470 μm which is connected to the VHF power source. We used $Ar/SiCl_4$ mixtures for nc-Si source for safety. H_2 was added to convert exhausted Cl to HCl. Electron density of micro plasma (N_e) was estimated by Stark broadening of H_β, and found that N_e is 1-3*10^{15} cm^{-3}. Rotation temperature was measured to be approximately 1500 K. Intensity ratio of Si(288 nm)/Ar(750 nm) increased linearly with increasing initial concentration of $SiCl_4$. If the residence time was 30 μs, particle nucleation seemed to start in the discharge region, and particles keep growing involving impurity elements such as N or Cl. On the other hand, when residence time was set to shorter than 10 μs, the amount of impurities can be minimized. Under this condition, Raman spectra showed crystalline silicon peak around 520 cm^{-1}. TEM image also indicated the size of synthesized nc-Si to be in the range of 4-20 nm.

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