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Generation of Charged Nanoparticles and Their Contribution to the Thin Film and Nanowire Growth during Chemical Vapour Deposition

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Abstract : The theory of charged nanoparticles suggested that in many Chemical Vapour Depositions (CVD) processes, Charged Nanoparticles (CNPs) are generated in the gas-phase and become a building block of thin films and nanowires. Recently, the nanoparticle-based crystallization has become a big issue since the growth of nanorods or crystals by the building block of nanoparticles was directly observed by transmission electron microscopy observations in the liquid cell. In an effort to confirm charged gas-phase nuclei, that might be generated under conventional processing conditions of thin films and nanowires during CVD, we performed an in-situ measurement using differential mobility analyser and particle beam mass spectrometer. The size distribution and number density of CNPs were affected by process parameters such as precursor flow rate and working temperature. It was shown that many films and nanostructures, which have been believed to grow by individual atoms or molecules, actually grow by the building blocks of such charged nuclei. The electrostatic interaction between CNPs and the growing surface induces the self-assembly into films and nanowires. In addition, the charge-enhanced atomic diffusion makes CNPs liquid-like quasi solid. As a result, CNPs tend to land epitaxial on the growing surface, which results in the growth of single crystalline nanowires with a smooth surface.

Keywords : chemical vapour deposition, charged nanoparticle, electrostatic force, nanostructure evolution, differential mobility analyser, particle beam mass spectrometer
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