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Control of nanoparticle formation in reactive plasmas and its application to fabrication of green energy devices

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We focus on the bottom-up paradigm for nanoscience and nanotechnology. The bottom-up processes can be categorized into self-organization and guided assembly processes [1]. Few reports on guided assembly processes in nanoscale have been provided. Guided assembly should be developed more in depth, because it can make extreme savings on materials and energy as well as be useful for building complex nanosystems, especially far from thermal equilibrium. We are developing “plasma nano-factories” which are such bottom-up guided assmbly processes and miniature versions of macroscopic conventional factories [1-5]. Instead of human being and robots in macro-factories, ions and molecules in plasmas convey nano-blocks to their destination and assemble them. Plasma nano-factories have three advantages: controlled agglomeration and transport of nanoblocks as well as parallel processing over large area at relatively low temperatures. Here we outline our efforts towards such plasma nano-factories. First we briefly summarize important features of formation and growth of nanoparticles in reactive plasmas and then describe in-situ methods for detecting nanoparticles in reactive plasmas. We show several key control methods of the size, size distribution, and structure of nanoparticles, their agglomeration and transport as well as sticking. Finally we describe applications to fabircation of green energy devices such as low energy consumption LSI’s, solar cells, and Li ion batteries [6-8].
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