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Academic Roadmap of Plasma Process Technologies

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The Plasma Electronics Division of the Japan Society of Applied Physics published an academic roadmap of plasma process technologies in 2007 and revised it in 2009 [1]. We classify future devices into 3 kinds from the viewpoint of their fabrication processes. They are electronics in the near future, molecular-level devices in the future, and ultimate atomic-level devices. We describe briefly research subjects for realizing fabrication processes of such devices. The description is divided into three parts of top-down processes, bottom-up processes, and base technologies useful for both top-down and bottom-up processes. For Top-down processes, one important research subject is to find out methods to control generation of reactive species and spatial profile of their number density in plasmas of wide ranges of reactor size, pressure, and of various medium phases. Another is to control transport of each reactive species towards surfaces and its flux, kinetic energy. Such control may bring about selective irradiation of a single species of a well defined incident energy, atomic layer deposition and etching at a practical reaction rate, and manipulation of bio-molecules, and so on. For bottom-up processes, an important research subject is to realize defect-free self-organized growth at a high growth rate. We may establish well-defined self-organization by combining knowledge of bottom-up processes with that of top-down ones. Tow base technologies are diagnostics and simulation. We need non-intrusive, in-situ, high-speed diagnostics of multiple species, surface reactions on nano-structures. We also need high-speed multi-scale simulation with high accuracy as well as database of elementary reactions on surfaces and in gas. These future science and technologies will be integrated to realize ultimate top-down and bottom-up plasma processes.

[1] http://www.jsap.or.jp/english/aboutus/academic-roadmap.html