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Some issues on the plasma surface engineering For the last 20 years

- toward a new era of plasma surface engineering -

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"Plasma surface engineering (PSE)" has been developed based on the trinity of "Materials science", "Surface science" and "Plasma science" in a special close connection with the development of various kinds of materials. In order to foresee the further of PSE, therefore, it is essential to understand the trends of materials. One of the most important trends is the upsurge of the concept of "Materials system". This is an organized integration of materials that works in unison based on complex interaction and effects in various types of environments. It has been widely recognized as the root of epoch-making achievements in a variety of technologies and, I believe, will surely be the core of materials science and engineering in the 21st century. Accordingly, the role of PSE should expand to cover not only "Surfacing" but also "Interfacing", since design and creation of highly functional interfaces (including surfaces) are becoming more critical in developing novel materials systems. The significance of "Interfacing" is made very clear by considering that the integration and organization of various kinds of materials has given prominent impacts in the areas of biomaterials, semiconductor devices and even structural materials.

Recalling my 30-year research career, I have been engaged in studying plasma processing based on materials science, i.e. plasma materials engineering, for the last 30 years. I started with the study of thermal plasma processing, especially plasma-particle interaction and co-condensation process of high temperature vapors, and then expanded to the ultrafine particles (so-called nano-particles) synthesis and also to plasma powder spraying and spray PVD & CVD for coating applications. 20 years ago, I also started the primitive studies of low pressure plasma-surface interactions including plasma vapor transport, sputtering, and CVD, followed by the studies of meso-plasma for super-high rate deposition of high quality thin films. These research fields would be characterized mainly by plasma generation, vapor condensation, and plasma-surface interactions. It is fortunate for me that plasma technology in these aspects has reasonably fit to the global trend of materials R&D; the shift from "monolithic bulk" to "materials system with thin film & coating" in this 30 years.

Meanwhile, it is my belief that the primary awareness in materials development is "scalability" and it must be considered at every step in research not to make all the efforts just for the sake of research. In this respect, it is a natural consequence that the plasma processing, as a whole, has been attracting global attentions for the last 20 years due to its inherent scalable and affordable characteristics. However, the present plasma technologies seem not yet evolved at the sufficient level to meet the requirements from the fields where this technique was not applicable in the past. This is, the rapidly growing desires from society would not be fully gratified if the currently available technologies are only used even in the PSE. How can we with it? I suppose that I may not be the only one who believes that the root and stream of valuable researches in PSE should be reviewed and understood first and then new principles have to be introduced based on fundamental research concepts.

With these in mind, in this lecture, I would like to address the future potential of PSE, with my firm belief that "Interfacing" shall be an essential cornerstone for development of novel materials systems that will benefit for human society.

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