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Recent Trends and Challenges in Plasma Science and Technology

H. Sugai[1,2]

[1]Faculty of Engineering, Chubu University, Kasugai 487-8501, Japan
[2]Plasma Nanotechnology Research Center, Nagoya University, Nagoya 464-8603, Japan

To date, plasma science and technology has provided innovative nanoscale materials processing in semiconductor industry. Subsequent to this first big "wave", the second new tide involving biotechnology and environmental technology are emerging in plasma applications. To open such new epoch, several breakthroughs in plasma sources, plasma diagnostics, materials processing and related data base are desired. In this presentation, a strategy for plasma science and technology innovation required in the next stage is explored, introducing recent works on mechanisms of Si oxidation and SiO_2 etching, production of larger-area high-density plasma and development of plasma monitoring tools. An importance of mutual interactions among different fields as well as international linkages is emphasized.

1. Are radicals always key species?

The most significant advantage of plasma technology is the low-temperature high-speed precise processing, which is mainly owing to abundant radicals produced in plasma. It has been widely believed that stable molecule (source gas) does not contribute to plasma etching and CVD processes. However, we recently found that molecule does play significant roles in some conditions. One example is low-temperature plasma oxidation of silicon surface where the key species is oxygen negative ion produced on the SiO_2 surface from the reaction between free electron and O_2 molecule [1]. The other example is SiO_2 etching by fluorocarbon plasma where parent molecules (C4F8) considerably contribute to etching under Ar ion bombardment [2].

2. Breakthrough via Novel Plasma Sources

Development of new sources such as meter-scale plasma, micron-scale plasma, and atmospheric plasma inspires novel plasma applications. We have recently developed a meter-scale high-density plasma usable in giant materials processing [3]. A two-meter-long one-meter wide flat plasma of density ~10^{12} cm^{-3} was uniformly produced by 915 MHz discharge to deposit microcrystalline silicon thin films.

3. Breakthrough via Novel Diagnostic Tools

Development of innovative diagnostic methods is inevitable to understand and control plasmas. Recent progress in the study is introduced.

4. Breakthrough via Exotic Interactions

Interaction among different fields (physics vs chemistry, company vs university) often leads to unexpected findings and progresses. Nagoya University established a new center called *Plasma Nanotechnology Research Center*, which will increase opportunities for such interactions, particularly the international exchange and linkage with Korean partners.

[References]

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