Investigating R&D Committee on Plasma Surface Technology

Technical Committee on Electrical Discharges,
Plasma, and Pulsed Power Technologies

1. Objective

Chemical interactions between plasma and solid surfaces are applied to enhance the performance and function of various material surfaces. Plasma surface treatment technology is classified into film deposition (PVD, CVD, thermal spraying, etc.), diffusion treatment (carburizing, nitriding, etc.), and surface modification (addition of functional groups, etc.). We find its applications to be quite diverse in variety such as control of frictional and tribological properties, improvement of biological properties, control of hydrophilicity and adhesion properties, addition of gas barrier properties, and semiconductor processing. In fact, these plasma surface technologies have been developed in different fields individually. Therefore, further technological developments is expected by comprehensively understanding trends in these technology developments and by efficiently sharing information on common problems for each technology. The aim of this investigation committee is to investigate progress in plasma surface technology in each field and share information among researchers belonging to each field. Although plasma surface technology is being researched also in other academic societies, this committee will focus on the viewpoint of "electrical engineering" to clarify the role of the IEEJ.

2. Background

Plasma surface treatment technologies have made unique advancements over the course of 50–60 years in different fields, each with a different history. Under these circumstances, the "Technical Committee on Material Surface Modification Process Technology using Plasma Mediums" was established in 1999, which attempted to systematically understand various plasma surface technologies. In the "Material Surface Modification Technology using Plasma" technical report of this committee, each technology was classified into coating and surface modification, where plasmas were classified into low temperature plasma and thermal plasma. In 2009 (10 years later), the "Investigation Committee on Advanced Plasma Sputtering Technology" was established, emphasizing the plasma sputtering technologies and summarizing the latest diverse applications for electronic device manufacturing and hard coating. The year 2019 marked another decade when new plasma surface technologies, which were not available 10 years ago, has been developed. Plasma sorts for surface treatment have become more diverse; e.g., atmospheric-pressure plasmas and in-liquid plasmas have been commonly used. Furthermore, research on new processes applying non-neutral plasmas and surface nanostructure formation (called the fuzz structure) in fusion reactor walls has made recent advancements. Now the time has come to re-evaluate plasma surface technologies according to such new concepts.

3. Objective

As described above, the variety of plasma surface technologies are becoming increasingly diverse. Here, we divide the relevant technologies into the four fields of "film deposition," "diffusion treatment," "surface modification," and "new concepts." The committee will comprehensively investigate topics on significant technical progress of these fields.

1) Latest trends in plasma film-deposition technology

- High-speed film deposition
  - ✓ Magnetron sputtering (HiPIMS)
  - ✓ Microwave-sheath voltage combination plasma
  - ✓ Atmospheric-pressure plasma
- Sputtering method with powder targets
- Energy-saving plasma spraying

2) Latest trends in plasma diffusion technology

- High-speed diffusion treatment with thermal plasma
- Diffusion treatment with atmospheric-pressure plasma
- Diffusion treatment with discharge plasma in liquids

3) Latest trends in plasma surface modification technology

- Surface modification of fluororesin
- Hydrophilicity control for nanomaterials
- Plasma treatment for inside wall of porous materials
- Plasma processing using low-energy ions

4) New concepts in plasma surface technology

- Plasma processing with non-neutral plasmas
- Surface nanostructure (fuzz structure) formation

4. Expected effects

By sharing the latest trends and common problems, we would like to offer future technological progress and synergistic effects to all the research fields on plasma surface technology.

5. Term of investigation

Januray 2019 to December 2021 (3 years)

6. Committee members

Position	Name	Affiliation	Member/Non-member category of IEEJ
Chairperson	Ryuta Ichiki	Oita University	Member
Secretary	Kingo Azuma	University of Hyogo	Member
Member	Yasutaka Ando	Ashikaga University	Member
〃	Tamiko Ohshima	National Institute of Technology Sasebo College	Member
〃	Takayuki Ohta	Meijo University	Member
〃	Daisuke Ogawa	Chubu University	Member
〃	Akinori Oda	Chiba Institute of Technology	Member
〃	Jaeho Kim	National Institute of Advanced Industrial Science and Technology	Member

Position	Name	Affiliation	Member/Non-member category of IEEJ
Member	Yusuke Kikuchi	University of Hyogo	Member
〃	Takashi Kimura	Nagoya Institute of Technology	Member
〃	Tomoyuki Kuroki	Osaka Prefecture University	Member
〃	Hiroyuki Kousaka	Gifu University	Non-member
〃	Naoyuki Sato	Ibaraki University	Member
〃	Tatsuru Sirafuji	Osaka City University	Member
〃	Koichi Takaki	Iwate University	Member
〃	Nozomi Takeuchi	Tokyo Institute of Technology	Member
〃	Yasunori Tanaka	Kanazawa University	Member
〃	Kungen Teii	Kyushu University	Non-member
〃	Haruhiko Himura	Kyoto Institute of Technology	Member
〃	Masashi Yoshida	Daido University	Non-member

7. Activity schedule

Committee meetings: 3 times/year; Secretariat: once a year

8. Reporting format

A technical report shall be prepared to present the results.