Seminar

==========

Institute for Plasma Research

==========

Title: Superhydrophobic surfaces developed through argon plasma processing for self-cleaning and water harvesting technologies

Speaker: Mr. Vivek Pachchigar

Institute for Plasma Research, Gandhinagar

Date: 09th January 2023 (Monday)

Time: 03:00 PM

Venue: Seminar Hall, IPR

Join the online meeting: https://meet.google.com/uwb-fksu-muu

Abstract

In recent years, the fabrication of superhydrophobic materials with unique functional properties such as self-cleaning, anti-icing, anti-fogging, oil-water separation, water harvesting, omnibhobicity, oleophobicity, etc. have been a trending research interest among researchers. These materials exhibit excellent water repellency due to which they are suitable for a variety of industrial applications. Also, Plasma-based methods to achieve superhydrophobicity have received great attention due to their ability for large-scale production, fast processing, and environmentally friendly nature. Plasma-based processes such as ion beam irradiation, plasma etching, and physical vapor deposition are widely used to produce hydrophobic and superhydrophobic surfaces.

In the present work, argon plasma processing techniques have been used to produce superhydrophobic polytetrafluoroethylene (PTFE or Teflon), and copper surfaces which can be used for self-cleaning and water harvesting technologies, respectively. Firstly, a systematic static wettability study was carried out on the PTFE surface using low energy Ar ion beam. The effect of various ion beam parameters such as ion energy, ion dose, and angle of incidence was investigated in view of producing a superhydrophobic surface [1]. A detailed wettability investigation is also carried out by analyzing several wetting properties such as water contact angle, contact angle hysteresis, surface free energy, roll-off angle, and rolling speed. After investigating the static wetting behavior, it is important to investigate the dynamic wetting behavior of the PTFE surface. Using various dynamics factors including the spreading factor (β), contact time (tc), time of flight (ta), and the number of bounces, the bouncing dynamics of water droplets were investigated for self-cleaning application [2]. Radiofrequency (RF) Ar plasma etching process was used on the PTFE surface for producing an industrial-scale superhydrophobic surface. The influence of RF power, treatment duration, impurity, and surface temperature on Ar plasma-treated PTFE was studied [3]. Further, Ar plasma processing was used to produce a superhydrophobic copper surface for water harvesting devices. In this work, the effect of RF plasma etching on the morphology, wettability, and chemical composition of copper surfaces has been investigated. After this, a thin layer of PTFE is deposited on plasma-treated copper to achieve superhydrophobicity. The developed surface has been used to study the dropwise condensation and optimized in terms of maximum water collection. Finally, a working model of a water harvesting device has been developed and tested using superhydrophobic copper surfaces.

References:

[1] V. Pachchigar, M. Ranjan, S. Mukherjee, Role of Hierarchical Protrusions in Water Repellent Superhydrophobic PTFE Surface Produced by Low Energy Ion Beam Irradiation, Sci. Rep. 9 (2019) 8675. [2] V. Pachchigar, M. Ranjan, K.P. Sooraj, S. Augustine, D. Kumawat, K. Tahiliani, S. Mukherjee, Self-cleaning and bouncing behaviour of ion irradiation produced nanostructured superhydrophobic PTFE surfaces, Surf. Coatings Technol. 420 (2021) 127331.
[3] V. Pachchigar, U.K. Gaur, A. T. V., S. K. P., S. Hans, S.K. Srivastava, M. Ranjan, Hydrophobic to superhydrophobic and hydrophilic transitions of Ar plasma-nanostructured PTFE surfaces, Plasma Process. Polym. n/a (2022) e2200037.