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Enhanced Surface Properties of Gas Discharge Plasma-Irradiated Poly(tetrafluoroethylene) for Biological Applications

Hernando S. Salapare III[1,2], Beverly Anne T. Suarez[1,3], Hannah Shamina O. Cosiñero[1], Miguel Y. Bacacoo[1], and Henry J. Ramos[1]

[1] College of Science, University of the Philippines Diliman, Quezon City, Philippines,
[2] College of Science, Pamantasan ng Lungsod ng Maynila, Manila, Philippines,
[3] Graduate School of Science and Engineering, Doshisha University, Kyoto Japan

Poly(tetrafluoroethylene) (PTFE) materials were treated with CF_4 plasma produced in a gas discharge ion source (GDIS) to enhance its surface properties, particularly, to achieve stable and robust superhydrophobic surfaces and to enhance the materials' oleophilic property for biological applications [1]. Fig. 1 shows the schematic diagram of the GDIS device. The complete details of the facility and its operation are described in [2-5]. The discharge current, I_d and discharge voltage, V_d are 20 mA and 550 V, respectively. The irradiation time was varied from 30 to 90 minutes resulting to plasma energies ranging from 20 to 60 kJ. The plasma energy was calculated from the discharge current, the discharge voltage, and the irradiation time, since the use of the Langmuir probe is not possible due to the design limitations of the GDIS [2-5]. The characterizations employed on the untreated and treated PTFE samples are contact angle measurements, scanning electron microscopy, atomic force microscopy and Fourier transform infrared spectroscopy. Superhydrophobicity with water contact angles as high as 156° were observed on the treated samples (Fig. 2). The wettability of all the treated samples was found to be stable in time as evidenced by the statistically insignificant differences in the hysteresis contact angles. The enhanced hydrophobicity depended on the plasma energies (i.e. irradiation times, discharge current, and discharge voltage) and higher plasma energies produced surfaces with enhanced hydrophobicity. The plasma treatment also enhanced the oleophilic property of the materials' surface as seen from the decrease in the PDMS-oil contact angle from 33° to as low as 10° (Fig. 3). The superhydrophobicity of the modified PTFE and the enhancement of its oleophilic property were due to (1) the changes in the roughness of the surface, (2) the formation of nanoparticles or nanostructures on the surface, and (3) the changes in the surface chemistry [1].

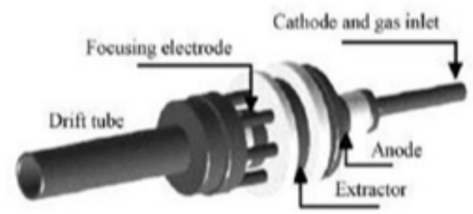

Figure 1. Schematic diagram of the GDIS

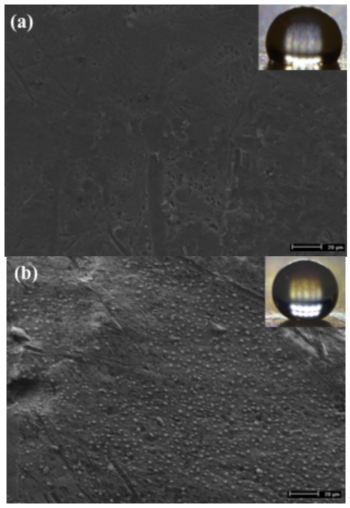

Figure 2. (a) SEM image of a representative sample from the untreated group showing a contact angle of 119°, and (b) typical SEM image from the group processed using CF_4 gas at 60 kJ plasma energy showing nanoparticles on the surface and with a contact angle of 156°.

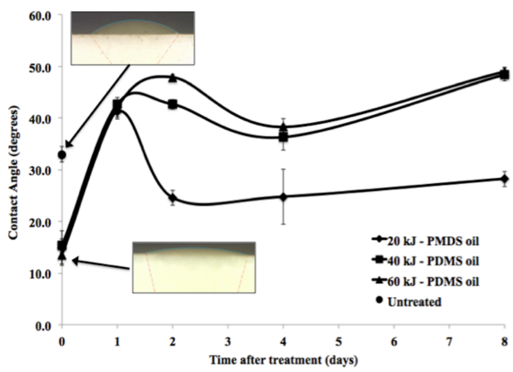

Figure 3. Change in the static PDMS-oil contact angles as a function of time after exposure to CF_4 plasma.

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