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Generation of anti-fog polymers by O_2 plasma treatment

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Polymers have many applications due to their properties: light weight, mechanical strength, hardness, high melting point, chemical stability, surface reactivity and can be designed in different shapes. Due to this advantages polymers are widely used in industry as windows, protect coating and so on. As a consequence to use them in high humidity environment the anti-fogging property comes to first place. Toward to the widely used coating method, plasma treatment of polymers is lower cost, and has capability for large-scale production.

To characterize anti-fogging property wettability is chosen. Chemical composition of polymers and their structure and morphology have an influence on the surface-free energy and as follows have a great influence on wettability. The wettability of a polymer surface is characterized by contact angle between solid and liquid interfaces.

Fig. 1 illustrates electron-beam plasma generating system used in experiment. Electron gun 1 generates and forms continuous electron beam 3 in high vacuum chamber 2; then the electron beam is transported to reaction chamber 9 through injection window 4. When the reaction chamber is filled with some plasma generating gas the electron beam excites plasma in a certain zone of this chamber and plasma cloud 11 is formed [1]. Sample 10 is treated. As a sample is chosen polymethyl methacrylate (PMMA) with size 20 mm X 20 mm.

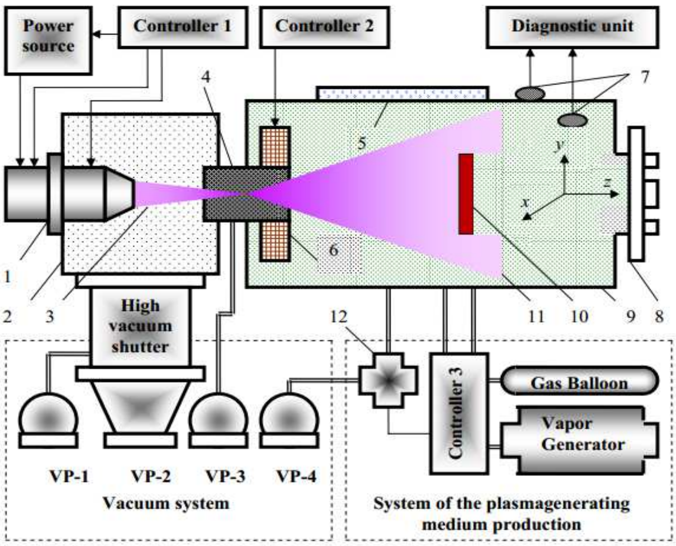

Fig.1. Electron-beam plasma generating system

Oxygen gas is used as a plasma generating medium. The polymer modification effects are resulted from the combined action of numerous factors inherent to the electron-beam plasma namely: fast electrons (high-energy electrons of the electron beam and secondary electrons of moderate energies), heavy plasma particles (neural and ionized particles in ground and excited states, radicals) , X-ray radiation (bremsstrahlung) that is generated when the fast electrons decelerate in gaseous medium and in solid matter. Table 1 shows experiment parameters.

Table 1. Experiment parameters

Neutral and ionized atoms temperature	Electron density	Electron beam current	Gas pressure	Treatment time
T_n ,$T_i \approx 300$ K	$n_e \approx 10^8 - 10^{13}$ cm^{-3}	1 mA	1 Torr	10 min

As a result contact angle decreases from 70° to 56° (fig. 2 and fig. 3 respectively). Contact angle is measured by KSV CAM 101 system [2]. By varying the experimental conditions (gas type, pressure, electron-beam power, generating hybrid plasma, changing the position of the sample in the plasma cloud, etc.) can be achieved better required results.

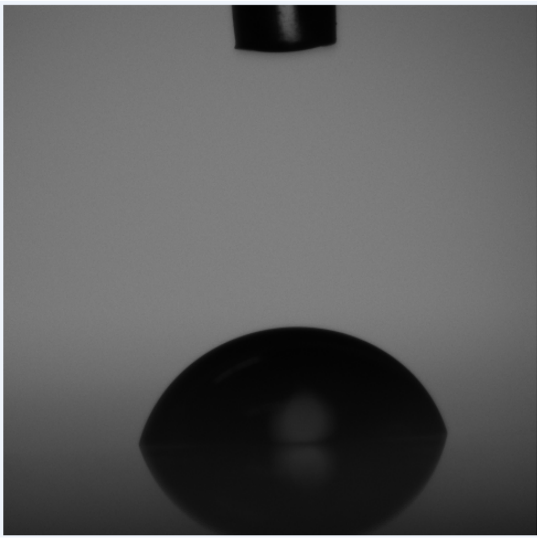

Fig.2. Contact angle before treatment

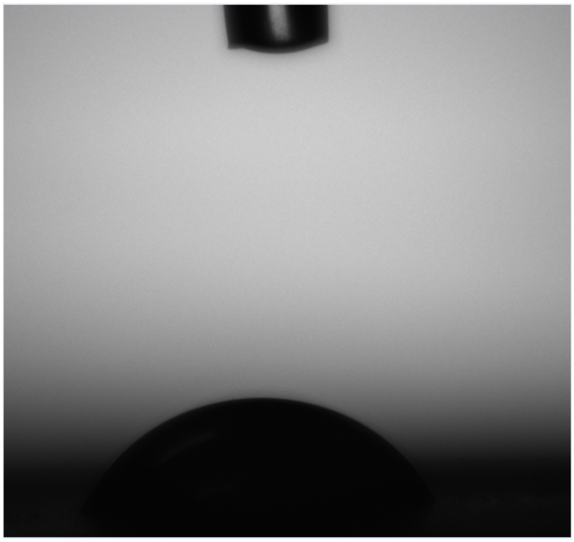

Fig.3. Contact angle after treatment

References

1. *Vasiliev, M. N.*, *Mahir, A.* H. Electron-beam plasma systems in industrial and aerospace applications // Publications of the Astronomical Observatory of Belgrade. 2008. vol. 84, pp. 421-425.
2. Contact angle measuring system KSV CAM 101 manual: www.ksvltd.com