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LIPSS formation by nanosecond laser irradiation of Poly(ethylene terephthalate) reinforced with Expanded Graphite

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The formation of Laser Induced Periodic Surface Structures (LIPSS) has demonstrated to be useful to structure in the nanoscale many types of materials including polymers [1]. This technique requires the irradiation of the surface of the sample with polarized laser pulses at fluences below the ablation threshold. The formation of LIPSS can be explained as a modulation of the depth of the surface resulting from an inhomogeneous intensity distribution, due to the interference between the incoming and the surface-scattered waves, and a positive feedback process. This leads to the formation of structures with a spatial period close to the laser wavelength, aligned parallel to the polarization of the laser beam.

Expanded Graphite (EG) is becoming a common reinforcement agent in polymers in order to improve substantially some of their properties, for instance, mechanical resistance or electrical conductivity. Poly(ethylene terephthalate) (PET) is a widely used polymer because of its excellent mechanical and chemical properties, and on the other hand, since it allows homogenous and simple dispersion of carbon based fillers [2].

In this work, formation of LIPSS was studied in PET and PET+EG 0.4 wt% films. Laser irradiation was carried out using a Q-Switched Nd:YAG laser (266 nm, 8 ns, 1-10 Hz). Geometrical features of LIPSS as well as mechanical properties and wettability of the processed surfaces were investigated as a function of the irradiation time and fluence.

Topography of the irradiated samples was measured by atomic force microscopy (AFM) in tapping mode. Periodical ripples were obtained for both materials. We found that the formation of good quality LIPSS depends strongly on the parameters of irradiation. AFM images were analyzed to extract statistical data about the geometry of the ripples. In both cases, ripples have a period close to the irradiation wavelength and were formed parallel to the polarization of the laser beam.

Nanomechanical properties were measured by AFM with PeakForce Quantitative Nanomechanical Mapping (PF-QNM) method, obtaining maps of elastic modulus and mechanical adhesion resistance. Results show that the elastic modulus is lower for PET than for PET+EG 0.4 wt% before irradiation, remaining in this condition after irradiation. PET exhibits better adhesion properties than PET+EG 0.4 wt% before irradiation. In the presence of LIPSS, adhesion decreases in both materials.

Contact angle (CA) measurements were carried out using water as reference liquid. The study shows that the CA of water in irradiated samples decreases in both materials, therefore, the material becomes more hydrophilic after irradiation.

References.

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