Modification of Polymeric Surfaces by IR and UV Laser Irradiation

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It is well known that laser surface treatment, and in particular laser ablation process, is a good method to modify surfaces by removing small quantities of material without causing thermal damage. The interaction of UV laser with polyatomic molecules induces photochemical reactions and thermal processes, while IR irradiation gives rise mainly thermal decomposition, because the photochemistry process is reduced due to the low photon energy [1–3].

In this work laser irradiation to modify the morphology of the polymeric surfaces was utilized. Contact angle and roughness measurements were performed in order to get information on the wettability on the processed samples before and after the treatment. The treated polymers were Poly(Methyl MethAcrylate) (PMMA) and Ultra High Molecular Weight Polyethylene (UHMWPE). In fact they are employed in many fields for their good chemical-physics properties, and particularly for biomedical use, it is important to control the wettability of their surfaces when they are utilized to make prosthesis devices [4].

The processing was performed by two different laser sources operating in the UV and IR range. The UV laser was a pulsed KrF excimer laser of 248 nm wavelength, while the IR one was a pulsed CO_2 laser of 10.6 μm wavelength. The utilized laser fluences were 0.3 J/cm^2 and 1.7 J/cm^2 for KrF and CO_2 laser respectively, due to the different laser ablation threshold [5]. The polymers were irradiated by several laser shots with perpendicular incidence, in air atmosphere, in order to study the influence of the laser shots number on the morphology modification. Fig.1 shows the trend of the contact angle versus laser shots number, while Fig.2 shows the surface roughness trend as a function of the laser shots number. As it is possible to observe, the polymers show a change of wettability and roughness after the laser treatment. According to the contact angle data plotted in Fig.1, PMMA under UV irradiation shows an initial decrease of the contact angle value until thirty laser shots. A similar behaviour was found for PMMA under IR irradiation. On

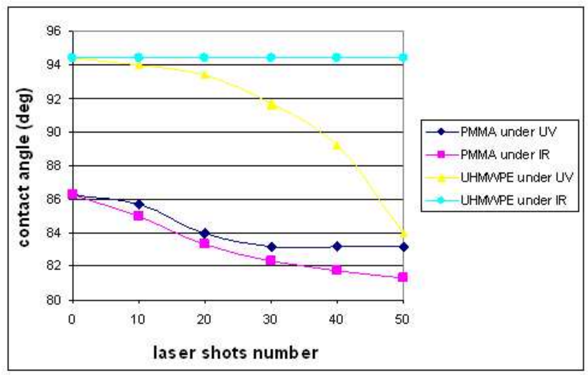

Figure 1. Contact angle trend as a function of laser shots number.

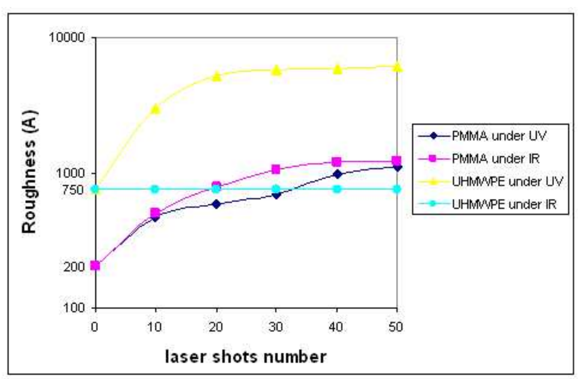

Figure 2. Roughness trend as a function of laser shots number.

the contrary, UHMWPE shows a change of the wettability only under UV irradiation. The decrease of the contact angle is the most accentuate among all the treated samples and it is possible to explain it by considering that the UV light induced more photothermal and photochemical effects respect to the IR, that can be also seen in the highest roughness value.

No changes of contact angle are observed with UHMWPE irradiated by CO_2 laser, because the polymer is transparent under IR irradiation and no photothermal and photochemical effects occur to modify the surface.

The hydrophilicity improve of the polymers by laser irradiation can be explained by the formation of various kinds of oxidized groups such as hydroxyl and carbonyl functions, with the rise of the pulse number [6].

The information about the roughness of surface after and before any treatment is useful to understand the wettability change of materials. In our case, the roughness measurements show an increase of the surface roughness for all irradiate samples with respect to the not treated ones. For PMMA samples under UV and IR irradiation, the roughness decreased the contact angle. This behaviour is well justified by theory because this polymer presented a wetting surface with a contact angle of 86° before the treatment [7]. Furthermore the UHMWPE show a hydrophilicity behaviour under UV treatment even if it is characterized by a no-wetting surface (contact angle = 94 °) before the irradiation. This result can be ascribed to the laser-surface interaction that gives an irregular roughness and generates peroxide radicals, at variance of different techniques for the increasing the roughness.

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