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Evolution the surface morphology and mechanical properties of Polyimide induced by Ion Beam Irradiation

Sk. Faruque Ahmed, Gun-Ho Nho, Myoung-Woon Moon*, Jun-Hyun Han, Kwang-Ryeol Lee[1]

Korea Institute of Science and Technology

*Correspondence author: mwmoon@kist.re.kr

Ion beam irradiation has been extensively used for surface modification of polymers, glassy metals and amorphous and crystalline materials at micron and submicron scales. The surface structures created by exposure to an ion beam range from dots, steps and one-dimensional straight wrinkles to highly complex hierarchical undulations and ripples. In general, the morphology of these nanoscale features can be selected by controlling the ion beam parameters (e.g. fluence and acceleration voltage), making ion beam irradiation a promising method for the surface engineering of materials.

In the work, we presented that ion beam irradiation results in creation of a peculiar nanoscale dimple-like structure on the surface of polyimide - a common polymer in electronics, large scale structures, automobile industry, and biomedical applications. The role of broad Ar ion beam on the morphology of the structural features was investigated and insights into the mechanisms of formation of these nanoscale features were provided. Moreover, a systematic experimental study was performed to quantify the role of ion beam treatment time, and thus the morphology, on the coefficient of friction of polyimide surfaces covered by nanostructure using a tribo-experiment. Nano-indentation experiment were performed on the ion beam treated surfaces which shows that the hardness as well as the elastic modulus of the polyimide surface increased with increase of Ar ion beam treatment time. The increased of hardness of polyimide have been explained in terms of surface structure as well as morphology changes induced by Ar ion beam treatment.

Keywords : Ar ion beam, Polyimide, nanostructure, Hardness, Friction.