# Characteristics of surface roughness and light fastness by dual ion beam irradiation

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## 1. Introduction

According to recent increase in use of polymeric materials and gradual increase of ultra violet radiation in sunlight, the demand of UV-absorbers is increasing in order to shield the radiation to control a damage of polymeric materials. The UV shielding method mainly used is to mix a low molecular compound into a polymeric matrix. This method has the defects that physical properties of the materials can deteriorate and that the faculty of UV shielding gradually weakens because of loss of absorbers mixed in polymeric matrix due to evaporation or effluence on the way of its processing or its use.

Ion implantation is one of the useful methods for modifying of polymer surfaces properties.

Ion beam irradiation provides a unique way to modify the mechanical, optical, and the electrical properties of polymers by depositing the energy of ions in the material on an atomic scale [1]. Beam irradiation of ions into polymers generally leads to radiation damage, which, in many cases, modifies the properties of the surface and the bulk of the material [2]. These modifications result from changes in the chemical structure caused in their turn by changes in the chemical bonding when the incident ions cut the polymer chains, break covalent bonds, promote cross-linking, and liberate certain volatile species [3]. For higher doses of radiation, which are commonly obtained with high fluencies of ions, carbonization can also take place [4]. The nature of these changes depends on the properties of the polymer, such as the composition and molecular weight [5]. In this study, we observed the change of the surface roughness and light fastness before and after ion beam irradiation.

## 2. Experimental

Polycarbonate/acrylonitrile-butadiene-styrene fibres (PC/ABS) irradiated with $N^+$, $He^+$ at the irradiation energy of 40~90keV and the dose range of $3x10^{16}$~$1x10^{17}$ ion/cm$^2$. The ion current density maintained under 7 $\mu$A/cm$^2$ to prevent overheating leading to melt-down at the polymer surface. The surface roughness changes caused by the ion beam irradiation were used to examine the surface morphology of fabric in this work using a scanning electron microscope (SEM) and atomic force microscopy (AFM). And we observed the improvement of light fastness using the ATLAS ci 3000+.

## 3. Results

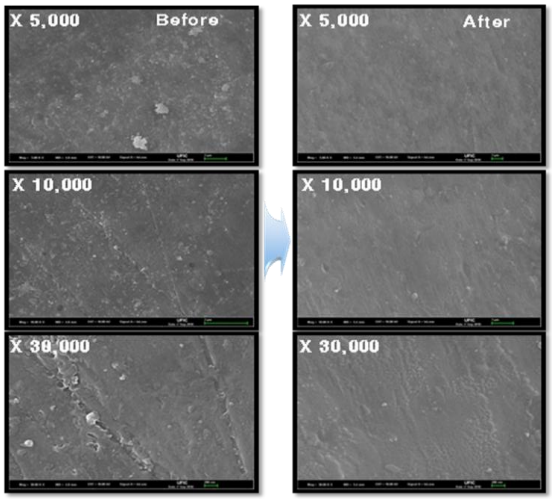


Fig. 1. SEM image of untreated and treated samples

SEM is the best known and most widely used tool for surface analyses. SEM micrographs of untreated and treated PC/ABS with 90keV beam voltage of the surface roughness of 2 times by dual ion beam irradiation (Nitrogen + Helium) are shown in Figure 1. It can be seen that, the surface roughness of the ions implanted sample with N 90keV $3x10^{16}$ions/cm$^2$ and He 90keV $3x10^{16}$ions/cm$^2$ were measured to be smooth and without cracks.

The polymer samples were irradiated with dual ion ($N^+$ + $He^+$) at 40, 60 and 90keV, $3x10^{16}$ions/cm$^2$. The surface roughness of PC/ABS is shown in Figure 2.

Experimental results showed that the surface roughness can be achieved to be smooth for the PC/ABS by dual ions implanted.

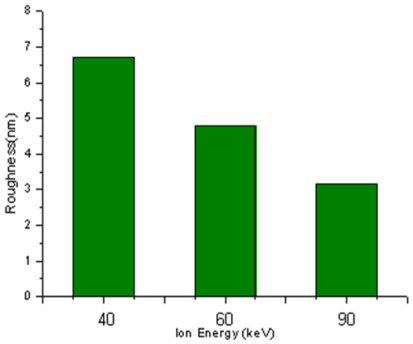


Fig. 2. The improvement of the surface roughness by dual ion beam treatment

Table 1. The light fastness by dual ion beam treatment

| Ion | Ion energy (keV) | Ion dose (ions/cm$^2$) | Light fastness |
|---|---|---|---|
| N + He | 40~90keV | 3E16 ~ 1E17 | 8days |
| | | | 11days |
| | | | 15days |
| | | | 18days |
| | | | 21days |

● Light fastness measurement

- ✓ Material : PC/ABS
- ✓ Instrument : ATLAS ci 3000+
- ✓ Method :
  Temp. : 89±3℃, Humidity : 50±5%, 340nm UV

In this study also provides PC/ABS with improved light fastness using ion beam surface treatment. Many types of polymeric materials are widely used in manufacturing a variety of parts due to qualities such as excellent mold-ability, lightweight, and relatively low price. However, many types of polymeric materials also have to shield the UV radiation damage. The polymer sample were irradiated with dual ion which have dose to $3x10^{16}$ ions/cm$^2$, $5x10^{16}$ ions/cm$^2$, $1x10^{17}$ ions/cm$^2$ at 40~90keV. Table 1 shows the light fastness was observed about 2 times by dual ion beam irradiation.

PC/ABS irradiated with dual ion which have dose to $3x10^{16}$ ions/cm$^2$ at 90keV was satisfied light fastness of 21days.

## 4. Conclusions

The surface roughness of PC/ABS with 90keV dual gaseous ion irradiation was measured to be 3.1nm. The general trend was that for increasing ion energy the surface roughness decrease.

Moreover, the results of this study show the improvement of light fastness by dual ion beam irradiation which is used two different irradiated ions.

From some measurements, it was found that the improvement in surface properties after ion beam treatment was related to graphite carbon or cross-linked carbon-double-bonding formed on the surface. The technology related to this study is applicable in automobile interior parts.

## ACKNOWLEDGMENTS

This work is supported by the Ministry of Education, Science and Technology of the Korean Government

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