SP3.04

Compensation of the Birefringence of an Optical Polymer by Doping with an Inorganic Birefringent Crystal and the Analysis of its Optical Properties

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Polymers have the advantages of easy processing, light weight and low cost as compared with glasses. However, the birefringence of polymers degrades the performance of optical devices that require maintaining the polarization state of incident light or focusing by lenses. The birefringence is mainly caused by the orientation of polymer chains during polymer processings.

In this report, we propose a compensation method for the orientational birefringence of a polymer. We call this method the "birefringent crystal dopant method". In this method, a rod-like inorganic crystal which is of nano size (< optical wavelength) is doped in a polymer. The crystal for this method must have the opposite birefringence to that of the polymer. When the polymer molecules are oriented, the doped crystals are also oriented and their birefringence compensates that of the polymer. Strontium carbonate ($SrCO_3$) which had an average length of about 200 nm and an average aspect ratio of about 3 was selected as a birefringent crystal and synthesized.

The crystal of $SrCO_3$ was doped into poly(methylmethacrylate-co-benzylmethacrylate)=78/22(wt/wt) film. The film was uniaxially drawn at 130°C. The orientational birefringence of the polymer at a wavelength of 633 nm was almost eliminated by doping with 0.3 wt% of the $SrCO_3$ crystal. The orientation function of the main chains of the polymer was measured by analyzing the IR dichroism. The orientation function of the film was reduced to about 50 % by the doped crystal. We called this phenomena the orientation inhibition effect. We estimated that the orientation function of the crystal was about 12.0 times larger than that of the polymer in our drawing condition. The analysis of the orientation functions showed that the birefringence of the film was compensated by the orientation inhibition effect and the high orientation degree of $SrCO_3$ crystal.