POLARIZATION CHANGES ON TRANSMITTED LASER LIGHT BY A POLYETHYLENE FILM

SIMONA DONȚU, TEODORA BREZEANU*, ESOFINA RISTICI*, C. COTÎRLAN*, D. SAVASTRU*, M. RISTICI** , ELEONORA NEMEȘ***, ELENA GROSU***, C. OPRAN*****

*National Institute of C&D for Optoelectronics INOE-2000, Bucharest
**Faculty of Physics, University of Bucharest
***National Institute of C&D for Plastics – INCERPLAST, Bucharest
****“Politehnica” University, Bucharest

Abstract. Advances at the plastics manufacturing level in such areas as co-extrusion and the production of specialty polymers and additives, result in the availability of plastics with improved characteristics. We have produced an agricultural photo-selective three layer co-extrusion film, manufactured at a thickness of about 200 µm. The film was made from different types of LDPE and LLDPE for each layer, and special chemical additives were incorporated into the polymers matrixes.

Key words: photo selective polyethylene film, PAR (Photosynthetic Active Radiation), He-Ne monochromatic laser, light polarization.

INTRODUCTION

Light is the main factor responsible for plant growth, as it drives photosynthesis [1]. Plants absorb radiation of 400–700 nm, called PAR (Photosynthetic Active Radiation) in their chlorophyll cells and use it as energy for photosynthesis [2]. To understand the impact of greenhouse glazing on crop production, we have to investigate how light interacts with cladding materials. Based on physical properties, surface orientation, and the number of layers of the glazing material, portions of the incoming light are either transmitted, scattered and/or absorbed. Polymers and particularly polyethylene film were not sufficiently studied for different applications and therefore did not meet all the requirements for agriculture. For this reason, a large number of additives were rapidly developed to improve the performances of these polymers in this original application [3, 4].

In this paper, using red and yellow laser monochromatic radiations, radiation from the middle of PAR range, the influence of the polyethylene film on the polarization properties of the light is studied. The results obtained lead to the

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conclusion that the polyethylene film can be used carefully in different monochromatic and polarized lightning due to their strong influence on the light polarization properties. Also, the position of the extrusion direction is an important function of light direction.

MATERIALS AND METHODS

Advances at the plastics manufacturing technology in such areas as co-extrusion technology and the production of destined polymers and additives, are resulting in the availability of plastics with improved characteristics. We have produced an agricultural photo selective three layers co extrusion film, manufactured at a thickness of about 200 μm. We have studied the influence of this film on polarization properties of two laser radiations. Experimental set-up consists of polarized and non polarized monochromatic laser lights, two polarizers, polyethylene film , a power meter and a Spiricon LBA-300 PC system.

One experimental set-up is composed of a He-Ne monochromatic laser (633 nm), a polarizer P that has the direction of vibration parallel to the laser vibration direction, an analyzer A and a Melles-Griot power meter (Fig. 1). The polyethylene films are placed between the polarizer and the analyzer. The first experiment is done when the flowing direction of the film is parallel with the polarizer vibration direction. The second experiment consists in changing of the extrusion direction of the film at α-angle from the vibrating direction of the polarizer. In both cases the direction of vibrating of the analyzer is rotated in the 0–360° range. The third experiment is done when the vibration directions of the polarizer and analyzer make an α-angle and the polyethylene film and vibration direction of polarizer make a β angle.

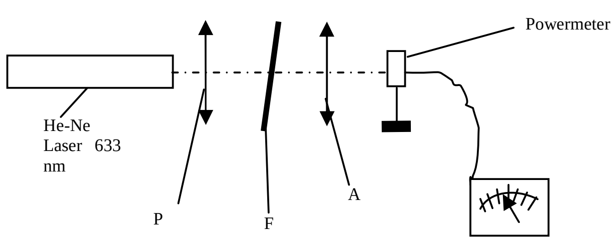

Fig. 1. Experimental set-up for measurement of the laser power transmission when photoselective film is at α-angle. P = polarizer; F = polyethylene film; A = analyzer.

The other experimental set-up consists of a He-Ne laser yellow radiation (594 nm), a polarizer and a Spiricon LBA-300 PC. The polyethylene film is placed between the Spiricon and polarizer (Fig. 2).

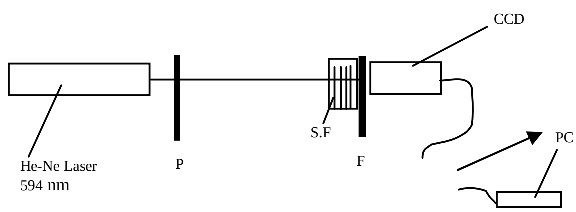

Fig. 2. Experimental set-up for registration of transmitted light dispersion. P = polarizer; S.F = filter system; F = polyethylene film; CCD = CCD camera; PC = computer (data acquisition).

The film is rotated. The Spiricon registers the dispersion image of the transmitted laser light by the film.

RESULTS AND DISCUSSION

Using a polarized, monochromatic radiation from PAR domain at wavelength of 633 nm, we can obtain some interesting results on the influence of the photo selective polyethylene on the polarization of light.

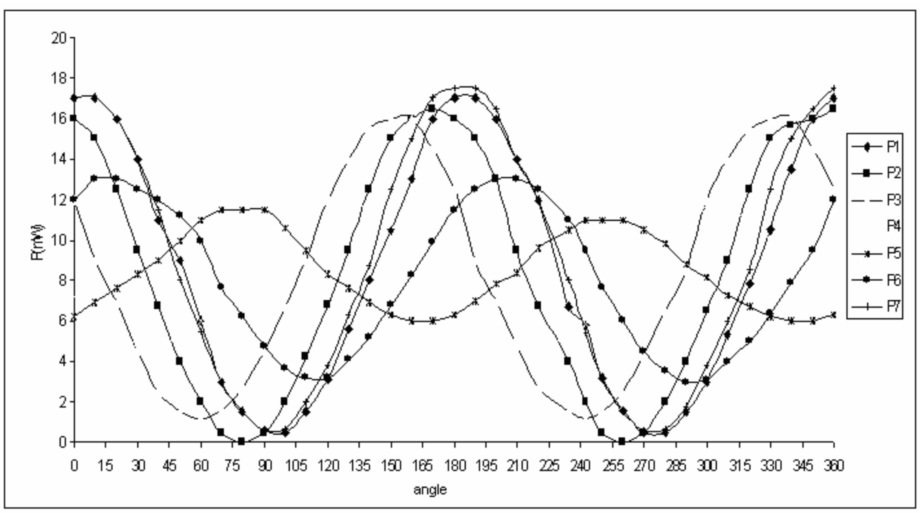

Fig. 3. Light emitted by a rotating analyzer after polarized laser light passed through the polyethylene film placed at different angles.

Fig. 3 shows the obtained curves P1 to P7 for different angles between the polarizer and the polyethylene film β. The β angle has the following values: 0° for P_1, 15° for P_2, 30° for P_3, 45° for P_4, 60° for P_5, 75° for P_6, 90° for P_7.

We can see that P_1 and P_7 are quite the same. This means that the vibration directions of the polyethylene and analyzer are like in the case when P_1 was obtained. The other curves show that the initial polarized light is changed by the polyethylene film. We consider that the extrusion technology makes the polyethylene film a birefringent material. This three layer polyethylene that we studied changes the polarized properties of a polarized light.

Also, from using Spiricon system and a 594 nm polarized laser radiation we have obtained the images in Fig. 4. We can see that the dispersion and the intensity are changed very much when the extrusion direction of the polyethylene is rotated at 45° regarding to 0° positions. This angle is between the extrusion direction and the vibration direction of the polarizer.

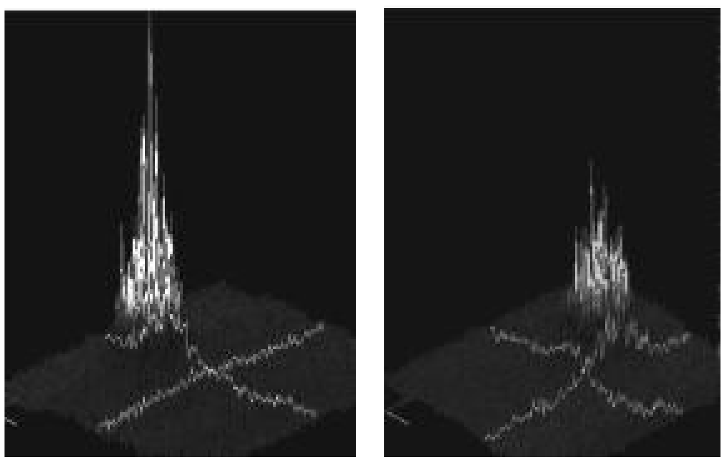

Fig. 4. Spiricon images of the transmitted laser light (594 nm) by the polyethylene film placed at 0° and 45°.

CONCLUSION

The studied three layer polyethylene film has a significant influence on the polarized laser line from PAR range. We will try to understand more about the changes of the polarization properties of a light transmitted by a polyethylene film.

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