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Résumé – It is widely known that microcrystalline structure of semi-crystalline thermoplastics induces an optically heterogeneous medium that eventually causes optical scattering. In case of building a predictive radiation heat transfer model for semi-crystalline polymers the scattering of radiation need to be taken into account [1]. Crystal formation in semi-crystalline polymers typically involves folding of polymer chains where the height of fold chains, which is named as lamellae thickness, is generally much smaller than their radial growth. Such type of radially-growth ordered chains eventually create larger structures, where both the crystalline and non-crystalline regions are named as spherulites [2].

In this study, the laser scattering profiles of polyethylene (PE) film samples were experimentally analyzed. Laser beam scattering tests were performed on PE using CASI® Scatterometer equipped with collimated monochromatic light at 632nm and, the bidirectional scattering distribution function (BSDF) of PE was obtained for the angles between 0° and 350°. In order to analyze the effect of microcrystalline structure on the scattering behavior of PE different film samples were prepared with different morphology but with identical thickness. Apart from it, directional-directional ($T_{\lambda\text{-directional}}$) and directional-hemipsherical transmittances ($T_{\lambda\text{-hemispherical}}$) of the identical PE samples were obtained via a FT-IR spectrometer and an integrating sphere [3]. In order to estimate the size of scatterer in PE, an inverse method was developed adopting the well-known optical scattering theories, such as Mie and Rayleigh-Debye-Gans (RDG) theories [3], [4]. Using the scattering theories, the laser scattering profile of PE was predicted considering arbitrarily adopted scatterer sizes and the predicted laser scattering profiles were compared to the experimental analyses. Thanks to this comparative study the equivalent scatterer size in semi-crystalline PE was estimated. The estimated parameter is called as equivalent scatterer size as, it was assumed that the scatterer is spherical while the microcrystalline structure of semi-crystalline polymers is much more complex. The obtained equivalent scatterrer size will be used for developing an advanced radiation heat transfer model that takes into account extinction coefficient (β_λ), which is function of both absorption and scattering characteristics of PE.

Références

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