10.1—1 A NEW TREATMENT OF THE THEORY FOR SMALL-ANGLE X-RAY SCATTERING WITH APPLICATIONS TO POLYSTYRENE CRAZES.* By M.-Y. Tang and J. F. Fellers, The University of Tennessee, Knoxville, Tennessee 37996-2200, and J. S. Lin, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37831.

Surface scattering phenomenon of electromagnetic waves by single or multiple layers of films are reviewed and a special treatment for the total reflection of x-rays is developed. This theory is applied to the analysis of the surface scattering observed in SAXS studies of two-phase matter in polymers having lamella stacks or a flat interfacial boundary structure. Important features of this vector theory are the ability to calculate the surface scattering invariant, the absolute scattering intensity, and surface randomness that gives rise to dispersion of specular reflection from perfectly smooth surfaces. By considering the interfacial surface roughness of polystyrene crazes, the surface scattering spectrum is calculated theoretically and compared to some experimental results. Also the theory is presented in such a way as to illustrate surface scattering ty to volume scattering, i.e., both two and three dimensional scattering events can be simultaneously treated. This gives rise to a new quantitative analysis of crazes in polystyrene.

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A study of the dependence of polystyrene craze morphology with respect to molecular weight parameters and stress history was performed at the National Center for Small-Angle Scattering Research. Small-angle x-ray scattering (SAXS) patterns are analyzed using refraction theory for the tensile axis scattering and volume scattering theory for the non-tensile axis, as prescribed from analysis. Morphological characteristics such as the surface scattering invariant, surface correlation distance, volume scattering invariant, microvoid fraction, and microvoid average size can now be determined from the statistical parameters contained in the fitted distribution function. Important information about the stress and time dependence of internal surface creation compared to microvoid creation can now be deduced from this analysis of the scattering function. Also the normalized scattering intensity of post fracture crazes is shown to be molecular weight dependent. Additionally, the crack propagation mechanism within the crazed material discussed by Kambour that the crack jumps back and forth across the craze is confirmed and calculated by the theory to be approximately 5 μm in steplenghth as experimentally observed by Behan and Hult.

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