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Optical Characterization of TRISO Fuel Particle Cross-Sections using Generalized Ellipsometry

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Quantification of preferred orientation of crystallites in the polycrystalline pyrolytic carbon coatings of TRISO fuel particles has been determined to be an important measurement for quality control. Excessive crystallographic anisotropy leads to unwanted anisotropic dimensional changes during irradiation, which can cause the TRISO coatings to fail. Experimental methods were developed in the 60's and 70's to measure this parameter using the fact that single crystal graphite is optically anisotropic in reflection. Since that time, considerable advancements have been made in the understanding of the effects of optical anisotropy in both experimental and theoretical realms. In this talk, we discuss a new method, based on the two-modulator generalized ellipsometer (2-MGE) to measure the optical anisotropy. This technique has been demonstrated to measure the optical diattenuation to an accuracy of ±0.002-0.005 and the preferred direction of the crystallites to ±1-2° with a spatial resolution of better than 5 microns. Diattenuation "pictures" of the nuclear fuel cross sections reveal that the inner pyrocarbon layer is far from uniform both in the degree of diattenuation and in the direction of the principal axis.

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