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Comparative Analysis of Parametric X-ray Radiation from Carbon Powder with Different Particle Sizes

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The classical Debye–Scherrer method, widely used to determine crystallite sizes in polycrystalline materials, has several fundamental limitations associated with the interpretation of diffraction peak broadening. A promising alternative for material structure diagnostics is the method based on the analysis of parametric X-ray radiation (PXR) generated by the interaction of relativistic electrons with the crystal lattice of a target. Unlike the Debye–Scherrer method, which relies on X-ray scattering, the PXR-based approach excites radiation directly in the studied structure by a charged particle beam, thus opening new opportunities for characterization.

Despite numerous experimental and theoretical studies of PXR from polycrystals, including metallic foils and powder targets, a systematic investigation of the dependence of PXR spectral characteristics on particle size over a wide range (from nanometers to hundreds of microns) for a material of the same chemical composition has not been carried out previously. This work is aimed at filling this gap.

The experiments were performed at the "Röntgen-1"facility (Lebedev Physical Institute, Troitsk). A 7 MeV microtron was used as a source of relativistic electrons. The target was carbon powder with particle sizes ranging from nanometer (~5 nm) to micrometer (~42 μm). PXR was recorded using Amptek SDD semiconductor detectors in Bragg geometry at fixed angles of 150° and 180° relative to the electron beam direction.

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