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X-RAY MICROBEAMS FOR 3-D MESOSCALE MATERIALS INVESTIGATIONS

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Polychromatic x-ray microbeam techniques exploiting the brilliance of third-generation synchrotrons have been developed for 3-D investigations of materials on mesoscopic length scales of tenths-to-hundreds of microns. Elliptically-figured Kirkpatrick-Baez mirrors are used to focus white x-ray beams to ~0.5 micron diameter, and new diffracted beam triangulation methods have been developed to obtain measurements of the local structure, orientation, and full stress/strain tensor of single crystal and polycrystalline materials with micron depth resolution. These capabilities provide new opportunities for non-destructive microstructural investigations of materials ranging from thin-films to bulk samples. The advantages of using polychromatic Laue diffraction for microstructure studies will be considered in connection with a discussion of the measurement and analysis techniques developed for automatic extraction of 3-D spatially resolved information. The power of the techniques developed will be demonstrated by micron resolution measurements of the stress/strain tensor in elastically strained Si, and the range of mesoscale materials physics investigations that can be addressed using these techniques will be discussed.

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