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Synchrotron X-Ray Topography Studies of the Evolution of the Defect Microstructure in Physical Vapor Transport Grown 4H-SiC Single Crystals

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Synchrotron White Beam X-ray Topography studies are presented of dislocation behavior and interactions in a new generation of one hundred millimeter diameter, 4H-SiC wafers grown using Physical Vapor Transport under specially designed low stress conditions. Such low stress growth conditions have enabled reductions of dislocation density by two or three orders of magnitude compared to the lowest previously reported levels. For example, detailed analysis of transmission geometry topographs recorded from wafers ranging in thickness from four hundred to seven hundred microns demonstrates extremely low defect basal plane dislocation (BPD) densities of just a few hundred per square centimeter on average. Lowering of dislocation densities to such levels provides a unique opportunity to discern the details of dislocation configurations and interactions which were previously precluded due to complications of image overlap at higher dislocation densities. In this paper, detailed topography analysis will be presented of the deflection onto the basal plane of c-axis threading dislocations of Burgers vector 1/3<11-20>, 1/3<11-23>, and [0001] which produces new types of dislocation sources as well as some novel faulted defect configurations. The implications of such substrate defect configurations on subsequently grown homoepitaxial layers and the prospects for further defect density reduction to unprecedented levels for Physical Vapor Transport grown SiC will be discussed. The importance of such defect reduction to improved device performance will be emphasized.