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P13: Calculations of Unintentional Axial and Planar Channeling of MeV Energy Ions in polycrystalline solids

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Recent measurements in the Ion Beam Lab at Sandia of displacement damage in polycrystalline metals caused by high energy heavy ions can be affected by unintentional channeling where this damage is then less. In order to calculate the probability of ion channeling for random orientations of a wide variety of both ion beams and nanocrystals, the equations used to calculate channeling half-angles needed to be automated. The equations for half-angle planar and axial channeling were derived from Chapter 10 and Appendix 15 (written by M. L. Swanson), in the Handbook of Modern Ion Beam Materials Analysis (edited by J. Tesmer, M. Nastasi, J. Barbour, C. Maggiore, and J. Mayer), and were automated using Excel. Before this automation, charts for the Debye function, the adimensional axial and planar potentials of Moliere had to be read in manually. In this project we started by parameterizing the information in these charts. The axial and planar half-angles were then compared with the data presented in this chapter, and were found to be within 10 % of the measured values. To determine the unintentional axial channeling probability the half-angles (in radians) for the primary axial channeling directions (variations of 001, 011 and 111) were squared and summed to get an area on the unit sphere that represents the beam-crystal orientations that would result in axial channeling. The same was done for the primary planar channels, but here the half-angles are multiplied by 2π. The probability for axial or planar channeling is then the sum of these two areas divided by 4π. This poster presentation will cover the process used to automate the channeling calculations and the subsequent equations used to calculate the probability of unintended ion channeling in polycrystals. The program can be made available on request. Sandia National Laboratories is a multi-program laboratory managed and operated by Sandia Corporation, a wholly owned subsidiary of Lockheed Martin Corporation, for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000.