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Polytypism in Natural SiC Using Laue Microdiffraction at ALS 12.3.2

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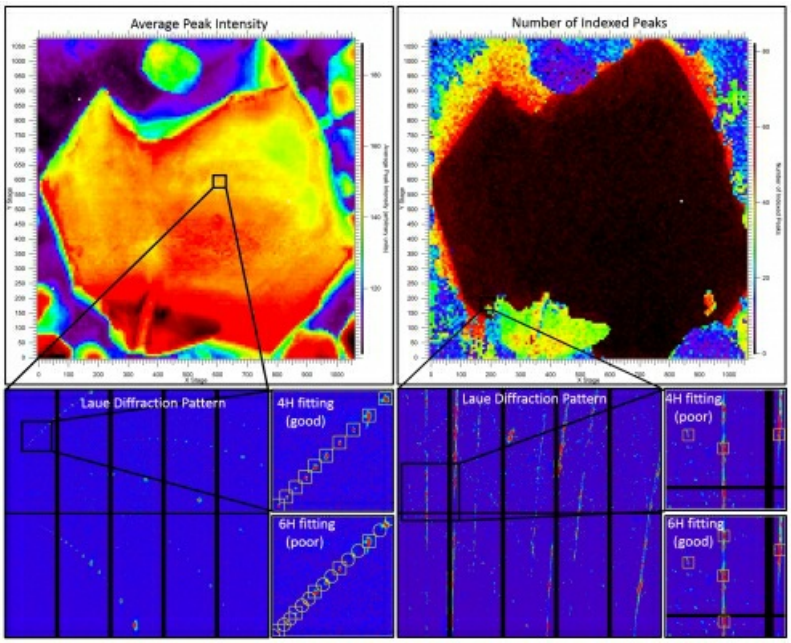
Silicon carbide (SiC, moissanite) is a common industrial material that is rarely found in terrestrial rocks and meteorites. It has been found to adopt over 300 different crystal structures, most of which are polytypic: they consist of alternating layers of Si and C, with only small stacking faults or shears distinguishing them from one another. In nature, only a few polytypes of SiC have been found, primarily a cubic zincblende type (3C-SiC), several hexagonal wurtzite types (4H-SiC and 6H-SiC), and a rhombohedral type (15R-SiC). Our natural silicon carbide sample is from a Miocene tuff (Yizre'el Valley, Israel) related to interplate alkaline basalt volcanism. Three SiC grains with native silicon and metal silicide inclusions were analyzed using Raman spectroscopy and synchrotron Laue X-ray microdiffraction accompanied by mapping at a 5-8 um resolution. SiC is found to crystallize in only the 4H and 6H polytypes. Due to the crystal orientation of the grains, as well as the significant difference in the c-axis length (~10 vs. ~15 um in 4H and 6H respectively), we were able to unambiguously assign polytypes to each diffraction pattern. Each grain contains large areas where one polytype dominates as a single crystal. In some cases, multiple stacking faults and misoriented polycrystalline aggregates of SiC occur at the 4H/6H interface. In other cases we see intercalation of the 4H and 6H crystals throughout the diffracting volume without a significant change in their crystallographic axes orientation, pointing to a possibly incommensurate crystal structure. Stress and strain are also mapped for all three grains, showing a slight (< 2 ppt) compressive strain in the y direction of all three grains, and a tensile strain in the x and z directions. In the SiC-2 grain, a mostly single-crystalline Si inclusion was found, with an exposed surface diameter of ~30 um. We examine residual strain in Si by both Laue X-ray diffraction and Raman spectroscopy, and find results to generally agree between the two measurements.



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