

RAPID ANALYSIS OF TERNARY PHASE DIAGRAMS USING SYNCHROTRON RADIATION

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We are developing techniques for the rapid evaluation of the crystal structure and materials properties of a wide range of materials. As a demonstration, we have analyzed the well-understood Fe-Cr-Ni ternary phase diagram. The components are deposited sequentially on Al₂O₃ substrates in wedge-shaped layers using e-beam sources and sliding shutters, followed by heating in vacuum to interdiffuse the elements.

The sample is analyzed using undulator radiation at the Advanced Photon Source (APS). The sample is rastered under a 12 keV, 0.25 x 0.50 mm² beam. The diffraction pattern at each position is recorded by a CCD to determine crystal structure while fluorescence is monitored by a PIN diode to determine composition. For each sample, 2600 points on the ternary phase diagram are measured in 4 hours.

CCD images are integrated to give 2-theta scans, from which the domain of each of the three equilibrium phases (fcc, bcc, and intermetallic sigma phase) are found. The formation of Cr₂O₃ is also observed for long annealing times, leading to an apparent shift in the phase boundaries, since the metal will have less Cr than indicated by the fluorescence measurement. Otherwise, the measured phase boundaries are in good agreement with the generally accepted ternary Fe-Cr-Ni diagram.

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