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OPTICAL MICRODIFFRACTION IN LATTICE IMAGE ANALYSIS

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Our applications of lattice imaging to the study of phase transformations in alloys have recently incorporated laser optical techniques to improve microdiffraction capabilities by three orders of magnitude over that attainable in conventional transmission electron microscopy (1). The method is based on optical diffraction from lattice image negatives which have been taken under optimum conditions dictated by computed image simulation. In this paper we present the optical microdiffraction data of two experiments to illustrate the role of this technique in metallurgical analysis.

1) Recent observations (2) in Mg₃Cd have revealed the occurrence in thin foils of a structural transition: hexagonal DO₁₉ → orthorhombic B₁₉. In orientations where the Mg₃Cd basal plane is parallel to the foil surface, selected area diffraction (S.A.D.) analysis fails to distinguish these phases. However, the inherent structural ambiguity is readily resolved using optical microdiffraction. Figure 1(a) shows an optical diffractogram taken from a specific area (40Å dia.) of an Mg₃Cd lattice image containing a single B₁₉ variant. Further analysis indicates that there are a total of three such variants existing in ~100Å domains, all of which add in conventional S.A.D. patterns to duplicate the pattern of the DO₁₉ phase. The optical diffraction pattern in Fig. 1(b), taken from a single DO₁₉ domain, is shown for comparison.

2) The composition modulations present in spinodal Au-Ni alloys have characteristically (3) small wavelengths (λ); nevertheless, measurements of λ can be made by locally averaging the fringe spacings in a lattice image using optical microdiffraction and aperture diameters <λ. Figure 2 depicts the result for an aperture equivalent to 20Å diameter (λ ≈ 30Å) at the specimen plane. By moving the aperture in (equivalent) 10Å increments, an obvious variation in diffraction spot spacing is produced. In this case not only is the local wavelength rapidly recorded, but the amplitude of the composition modulation is captured as well.

These examples show that complementary to the lattice imaging technique, optical microdiffraction provides a relatively simple and highly accurate method of structural discrimination and chemical analysis. Our work in this area is continuing with applications to other complex metallurgical and ceramic systems.

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Optical microdiffraction patterns taken from single 100A domains in the lattice image of ordered Mg₃Cd distinguishing (a) one variant of the orthorhombic B19 structure and (b) the DO₅₁₉ structure in an [0001] zone axis.
Optical microdiffractions resulting from translating a 1mm (20Å equivalent) aperture in .5mm (10Å) increments normal to the (200) fringes of a spinodal Au-Ni alloy (λ = 29 3Å).
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