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IT-4-O-1791 Quantitative interpretation for angle selective backscattering image of iron oxide on steel

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The contrasts in backscattered electron (BSE) images were studied from the cross section of a heat-treated steel sheet using a scanning electron microscope (SEM) equipped with a conventional annular BSE detector (Σ igma, Carl Zeiss NTS GmbH). The specimen used was heat-treated low carbon steel with an oxide layer mainly composed of magnetite (Fe_3O_4). A cross-sectional specimen was prepared by argon ion irradiation (IB-09010CP, JEOL Ltd.) after polishing with diamond suspension. BSE images were observed at primary electron energies (E_p s) of 2 keV, 5 keV, 10 keV and 15 keV at various working distance from 2 to 15 mm for an identical area of the specimen (cross section). The take-off angles (θ ; measured from the specimen surface) of the detector were estimated to be 35-45°, 39-53°, 50-63°, 66-75° and 73-79° (except 2 keV) from the geometry of the detector and the specimen. The variation of BSE intensities between crystal grains was calculated from the images. According to the results, high E_p enhances bulk information and Z contrast, whereas low E_p improves surface information and channeling contrast. High θ also enhances bulk information and Z contrast, whereas low θ improves surface information and channeling contrast. In the case of the lowest θ , topographic information was enhanced by shadowing effect on BSEs, in addition to the amplification of channeling contrast. These results regarding channeling contrast and Z contrast can be understood by the ratio of low-loss electrons (LLEs) to the inelastic BSE components detected; LLEs contribute to channeling contrast, and their ratio increases with decreasing E_p and θ . The systematic results obtained in this study are useful for controlling SEM conditions in order to select Z and crystallographic information separately in BSE images for practical materials of interest.

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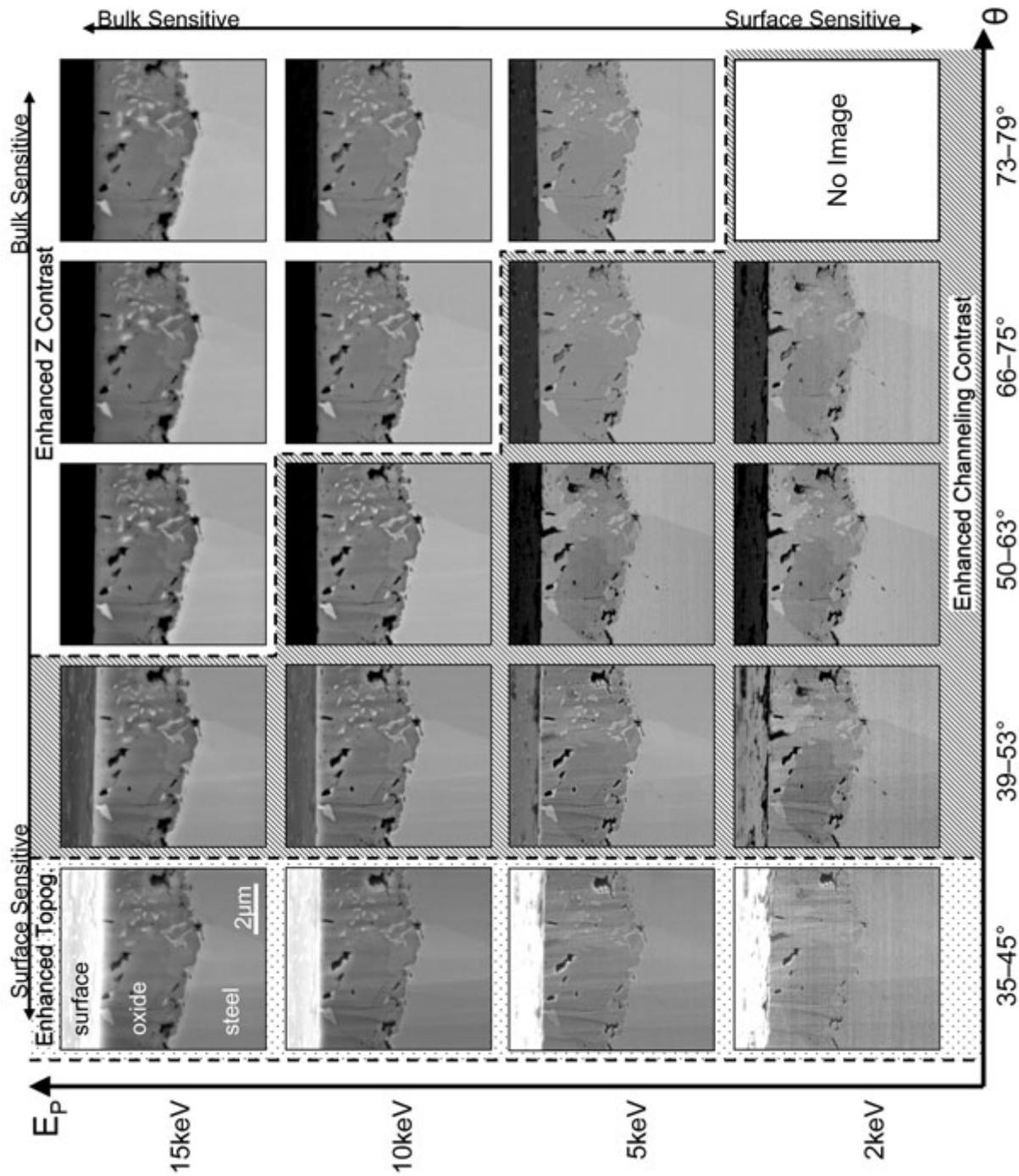


Fig. 1: Schematic diagram showing dependencies of the BSE contrast on the θ and E_p . The areas where channeling contrast and Z contrast are enhanced in the BSE images are indicated by shaded and unshaded areas, respectively. The area where topographic information and channeling contrast are enhanced is indicated by dotted area.