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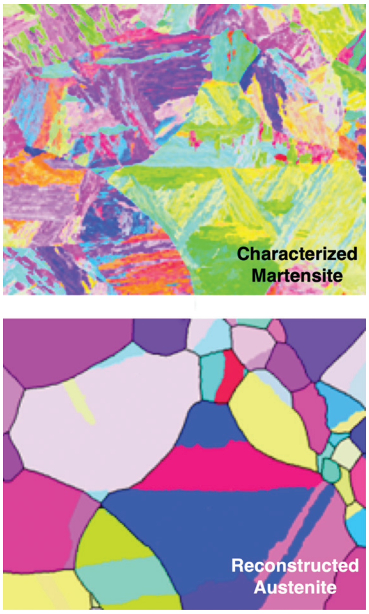
Highlights from Microscopy AND Microanalysis

Materials Applications

Probabilistic Reconstruction of Austenite Microstructure from Electron Backscatter Diffraction Observations of Martensite by AF Brust, EJ Payton, TJ Hobbs, V Sinha, VA Yardley, and SR Niezgoda, *Microsc Microanal* | https://doi.org/10.1017/S1431927621012484.

Understanding the mechanical properties of quench-and-temper steels requires an accurate representation of the prior austenite microstructure. Observations from electron backscatter diffraction (EBSD) data can be used to reconstruct the prior austenite microstructure but become obfuscated due to noise associated with the transformation. This includes variation in the orientation relationship (OR), the 24 potential martensite variants associated with a single prior austenite grain (PAG), plasticity associated with the phase transformation, indexing uncertainty associated with EBSD measurements, and the existence of annealing twins. Experimentally, etchant techniques require impurities, such as high concentrations of C and P, and fail to capture fine-grained microstructures. Most existing computational reconstruction techniques use point-to-point or flood fill algorithms that struggle in the face of increasing noise and fail to capture prior austenite twins. This work uses a clustering algorithm known as graph cutting to probabilistically reconstruct the prior austenite microstructure for 2 different steel specimens and a binary ferrous alloy based on the crystallography associated with the austenite to martensite transformation (Figure).

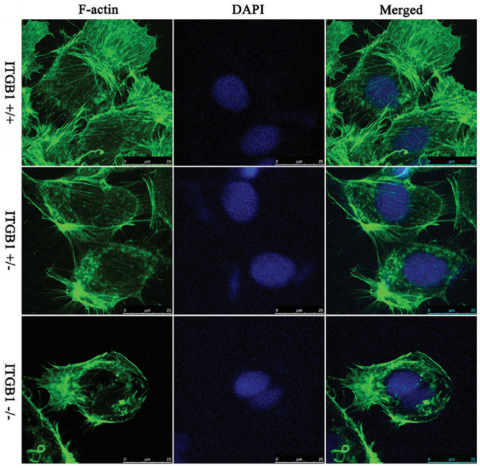


Enlarged section of EBSD-indexed martensite (top) and the reconstructed prior austenite microstructure (bottom) of an AF9628 steel specimen.

Biological Applications

ITGB1 Enhances the Proliferation, Survival and Motility in Gastric Cancer Cells by SN Cheng, XY Li, Y Yuan, CS Jia, LR Chen, Q Gao, Z Lu, RN Yang, GC Nie, J Yang, W Duan, L Xiao, and YC Hou, *Microsc Microanal* | https://doi.org/10.1017/S1431927621012393.

Gastric cancer (GC) is an important cause of mortality worldwide, especially in China. ITGB1 (Integrin β1, CD29) is a member of the integrin family that functions as a major adhesion receptor. As a potential cancer enhancer, the role that ITGB1 plays in GC progression is not clear. This work found that the high expression of ITGB1 was closely correlated with a poor prognosis for GC patients. Tumor malignancy-associated cell behaviors and microstructures were detected, imaged, and analyzed. Results indicated that ITGB1 deletion using the CRISPR/Cas9 method markedly decreased GC cell proliferation and motility and inhibited motility relevant microstructures such as pseudopodia and filopodia in ITGB1-deleted SGC7901 cells (Figure). Analysis of the STRING database for associations between proteins and western blot analysis indicated that ITGB1 contributes to the malignancy of GC mediated by Src-mediated FAK/PI3K/Akt signaling pathways. Taken together, this investigation showed that ITGB1 may be a potential targeting marker for GC diagnosis and therapy.



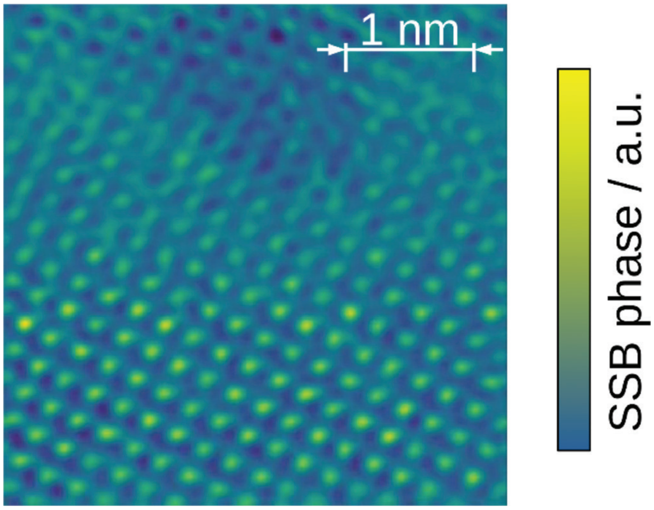
F-actin (green) illustrating decreased pseudopodia and filopodia in ITGB1-deleted cells (bottom row) compared to cells with ITGC1. Blue stain is DAPI showing nuclei (scale bar: 25 μm).

Microscopy AND Microanalysis

Techniques Development

Live Processing of Momentum-Resolved STEM Data for First Moment Imaging and Ptychography by A Strauch, D Weber, A Clausen, A Lesnichaia, A Bangun, B März, FJ Lyu, Q Chen, A Rosenauer, R Dunin-Borkowski, and K Müller-Caspary, *Microsc Microanal* | https://doi.org/10.1017/S1431927621012423.

A reformulated implementation of single-sideband ptychography enables analysis and display of live detector data streams in momentum-resolved scanning transmission electron microscopy (STEM) using the LiberTEM open-source platform. This is combined with live first moment and further virtual STEM detector analysis. Processing of both real experimental and simulated data shows the characteristics of this method when data are processed progressively, as opposed to the usual offline processing of a complete data set. In particular, the single-sideband method is compared with other techniques, such as the enhanced ptychographic engine, in order to ascertain its capability for structural imaging at increased specimen thickness. Qualitatively interpretable live results are also obtained if the sample is moved, magnification is changed, or the focus is optimized during the analysis (Figure). This allows live optimization of an instrument as well as specimen parameters during the analysis. The methodology is expected to improve contrast- and dose-efficient *in situ* imaging of weakly scattering specimens, where fast live feedback during the experiment is required.

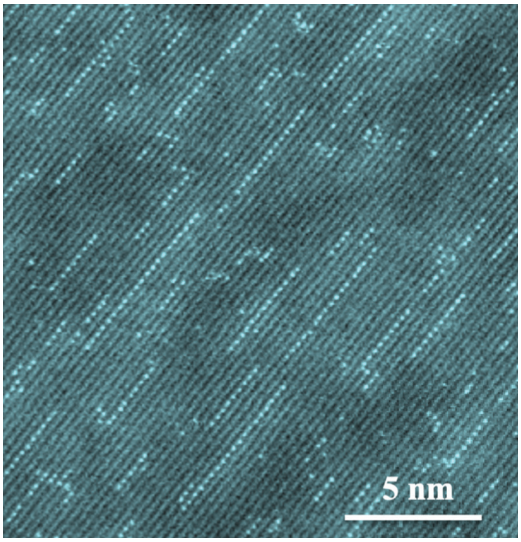


Live single-sideband reconstruction of a momentum-resolved STEM scan on a $SrTiO_3$ sample in [001] orientation. The focus was changed and optimized during the scan.

Review Article

Advances and Applications of Atomic-Resolution Scanning Transmission Electron Microscopy by J Liu, *Microsc Microanal* | https://doi.org/10.1017/S1431927621012125.

Atomic-resolution scanning transmission electron microscopy (STEM) was realized more than 50 years ago. The practical realization of aberration correctors to form sub-Ångstrom electron probes on STEM instruments, however, significantly expanded the impact of STEM and associated diffraction and spectroscopy techniques on solving a wide range of challenging materials problems. The flexibility in configuring STEM detectors to form the corresponding images makes the STEM instrument a versatile tool for exploring the intrinsic nature of matter with atomic-scale resolution, picometer precision, and single-atom chemical sensitivity for both heavy and light elements (Figure). This review provides an account of the development of STEM techniques with a focus on atomic-resolution imaging and its applications in materials characterization. Critical issues such as electron beam-induced effects and how to alleviate such effects are also highlighted. It is expected that ultrafast computers and electron detectors, robust image acquisition and processing algorithms, machine learning, and artificial intelligence will all play an increasingly important role in acquiring, analyzing, and correlating STEM data to materials properties.



Aberration-corrected high-angle annular dark-field STEM image of Ir single-atom chains on ZnO nanobelts. These single-atom chains are stable in air up to 600°C. These Ir atom chains demonstrated catalytic activity for carbon monoxide oxidation.