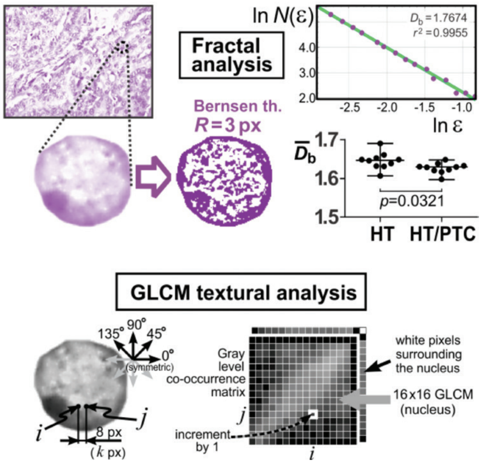
Highlights from Microscopy AND Microanalysis

Biological Applications

The Fractal and GLCM Textural Parameters of Chromatin May Be Potential Biomarkers of Papillary Thyroid Carcinoma in Hashimoto's Thyroiditis Specimens by M Dinčić, J Todorović, J Nešović Ostojić, S Kovačević, D Dunđerović, S Lopičić, S Spasić, S Radojević-Škodrić, D Stanisavljević, and AŽ Ilić, *Microsc Microanal* | doi:10.1017/S1431927620001683

Accurate diagnosis of Hashimoto's thyroiditis (HT) and papillary thyroid carcinoma (PTC) is sometimes hindered due to sharing of similar nuclear features. Quantification of the differences between HT-associated PTC (HT/PTC) versus HT alone specimens can facilitate diagnosis and reduce inaccurate diagnosis due to the subjective experience of an observer. We analyzed 250 segmented nuclei per group (25 nuclei per patient, 10 patients per group) using ImageJ software (NIH, Bethesda, MD, USA) for fractal analysis and an in-house written code for the gray-level co-occurrence matrix (GLCM) analysis (Figure). Malignant cells from the HT/PTC specimens showed lower chromatin fractal dimension (p=0.0321) and higher lacunarity (p=0.0038) compared to corresponding cells from the HT alone specimens. Additionally, we observed statistically significant differences for the five studied GLCM features: *Contrast*, *Correlation*, *Angular second moment*, *Homogeneity*, and *Entropy*. The differences in visual textures of follicular cell chromatin could be used for improved evaluation of distinctive features of HT/PTC versus HT in cytology and surgical pathology specimens.

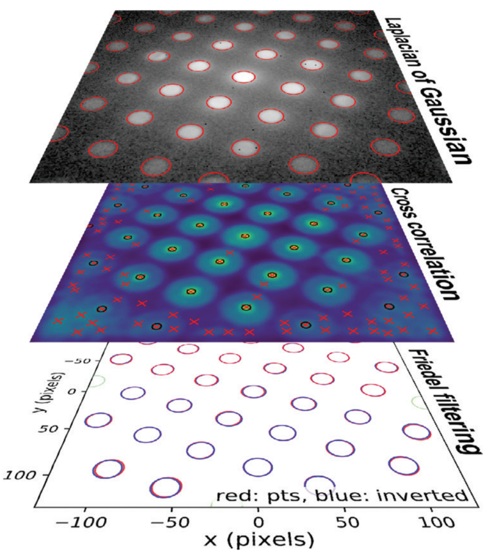


Nine parameters obtained using fractal and GLCM textural analysis showed significant differences in the visual textures of chromatin in HT/PTC versus the HT alone specimens.

Techniques Development

Fast Pixelated Detectors in Scanning Transmission Electron Microscopy. Part II: Post Acquisition Data Processing, Visualisation, and Structural Characterisation by GW Paterson, RWH Webster, A Ross, KA Paton, TA Macgregor, D McGrouther, I MacLaren, and M Nord, *Microsc Microanal* | doi:10.1017/S1431927620024307

New generations of radiation hard fast pixelated detectors incorporating direct electron technologies are revolutionizing aspects of scanning transmission electron microscopy (STEM). This has led to the burgeoning field of four-dimensional STEM (4D-STEM), where a slice of reciprocal space is recorded in high dynamic range and with low or zero readout noise at each probe position. This allows a multitude of analyses to be performed, with the potential of yielding greatly improved insights into a range of samples. We report two open source Python software libraries (fpd and PixStem) to enable the efficient processing and visualization of 4D-STEM data, and cover aspects of their use in performing STEM characterization of the structural properties of materials. Examples are given of virtual detector imaging, higher order Laue zone analysis, nanobeam electron diffraction, and scanning precession electron diffraction (Figure). In the latter, we demonstrate excellent nanoscale lattice parameter mapping with a precision≤0.06%. Extensive documentation is provided online, and all data and scripts used in the article are publicly available.



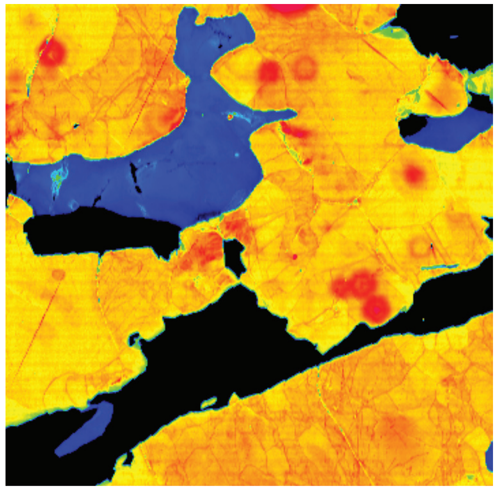
Processing steps of the lattice parameter extraction from 4D-STEM data from an MgO substrate acquired in SPED mode.

Microscopy AND Microanalysis

Materials Applications

Soft X-Ray and Cathodoluminescence Examination of a Tanzanian Graphite Deposit by CM MacRae, M Pearce, N Wilson, A Torpy, M Glenn, and S Russo, *Microsc Microanal* | doi:10.1017/S1431927620001294

Hyperspectral soft x-ray emission (SXE) and cathodoluminescence (CL) spectrometry has been used to investigate a carbonaceous-rich deposit to understand the crystallinity and morphology of the carbon and the associated quartz (Figure). Peaks within a hyperspectral CL map have been identified and fitted. The peak at 2.7 eV shows the subtle growth zoning of Ti^{4+} within the quartz grains, together with radiation halos from the ^{238}U decay. Using SXE spectrometry to study the graphite within the sample, we have been able to show that individual grains predominantly have a single orientation, and each grain's orientation can be readily mapped within a mineral specimen. A peak fitting approach to analyzing the SXE spectra was developed to project the C Kα $2p_z$ and $2p_{(x+y)}$ orbital components of the graphite. The shape of these two end-member components is comparable to those produced by electron density of states calculations, which has helped verify the technique. We show that the angular sensitivity of the SXE spectrometer is comparable to that of electron backscatter diffraction (EBSD).



Cathodoluminescence image showing growth zones in quartz (yellow regions). Overgrowths are evident in large grains, while smaller grains appear to be fused together. The red circles are radiation halos associated with alpha particle decay. (Image width = 720 μm).