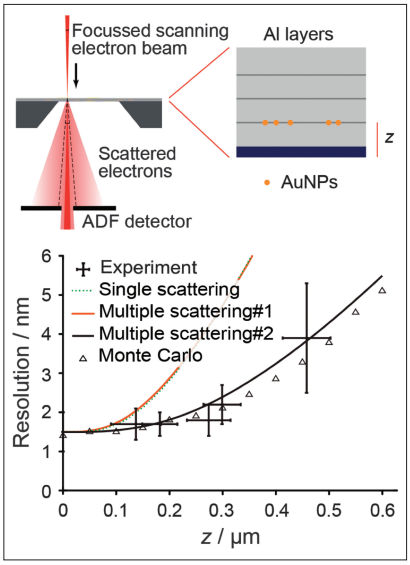
Highlights from Microscopy AND Microanalysis

Techniques and Materials Applications

The Influence of Beam Broadening on the Spatial Resolution of Annular Dark Field Scanning Transmission Electron Microscopy by N de Jonge, A Verch, and H Demers, *Microsc Microanal* 24(1) (2018) 8–16.

The spatial resolution of aberration-corrected annular dark field (ADF) scanning transmission electron microscopy (STEM) was studied as function of the vertical position z within a sample. The samples consisted of gold nanoparticles (AuNPs) positioned in different horizontal layers within aluminum matrices of 0.6 and 1.0 µm thickness. The highest resolution was achieved in the top layer, whereas the resolution was reduced by beam broadening for AuNPs deeper in the sample. To examine the influence of the beam broadening, the intensity profiles of line scans over nanoparticles at certain vertical locations were analyzed. The experimental data were compared with Monte Carlo simulations that accurately matched the data. The spatial resolution was also calculated using three different theoretical models of the beam blurring as function of the vertical position within the sample. One model considered beam blurring to occur as a single scattering event but was found to be inaccurate for larger depths of the AuNPs in the sample. Two models were adapted and evaluated that included estimates for multiple scattering. One of these models described the data with sufficient accuracy to be able to predict the resolution. Beam broadening depended on $z^{1.5}$ in the experimental data, a model including multiple scattering and Monte Carlo simulations.

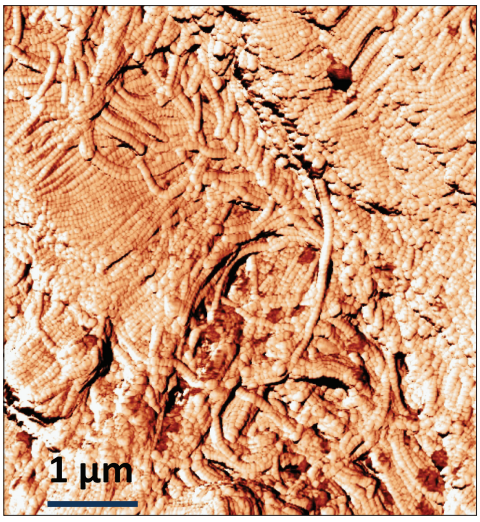


Resolution of STEM measured on AuNPs at different z in a sample consisting of Al layers. Experimental data were compared with different analytical models of beam broadening and with Monte Carlo simulations.

Techniques and Biological Applications

Early Effects of Ionizing Radiation on the Collagen Hierarchical Structure of Bladder and Rectum Visualized by Atomic Force Microscopy by SL Kotova, PS Timashev, GV Belkova, MV Kochueva, KV Babak,VA Timofeeva, EB Kiseleva, OO Vasilieva, AV Maslennikova and AB Solovieva, *Microsc Microanal* 24(1) (2018) 38–48.

Radiation therapy, used in the treatment of pelvic area malignancies, is associated with inevitable damage to the surrounding healthy tissues. We have applied atomic force microscopy (AFM) to track the early damaging effects of ionizing radiation on the collagen structures in the rat bladder and rectum. The first signs of the low-dose radiation (2 Gy) effect were detected by AFM as early as 1 week post irradiation. The observed changes were consistent with initial radiation destruction of the protein matrix. The alterations in the collagen fibers' packing 1 month post irradiation were indicative of the onset of fibrotic processes. The destructive effect of higher radiation doses was probed 1 day post treatment. The severity of the radiation damage was proportional to the dose, from relatively minor changes in the collagen packing at 8 Gy, to increasing collagen matrix destruction at higher doses, and complete collagen network restructuring toward fibrotic-type architecture at 22 Gy. The AFM study appeared superior to the light optical microscopy-based studies in its sensitivity to early radiation damage of tissues.



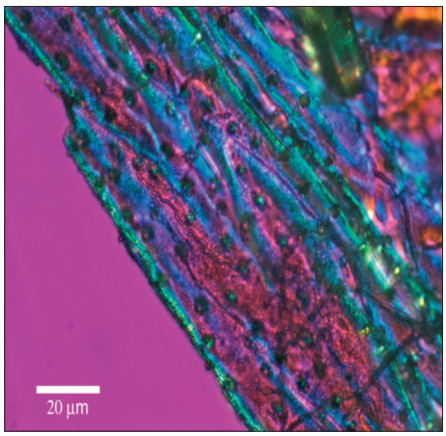
Oriented, tightly packed collagen fibrils forming thick fibers (signs of fibrosis) in the bladder extracellular matrix 1 month after irradiation at the dose of 2 Gy. Phase image, 6 × 6 µm.

Microscopy AND Microanalysis

Micrographia

Polarization Microscopy and Infrared Microspectroscopy of Integument Coverings of Diapausing Larvae in Two Distantly Related Nonsocial Bees by MLS Mello, BC Vidal, and JG Rozen Jr., *Microsc Microanal* 24(1) (2018) 75–81.

The larvae of the distantly related nonsocial bees *Ericrocis lata* and *Hesperapis rhodocerata,* which develop mostly under arid desert areas of North America and that spin (*E. lata*) or do not spin (*H. rhodocerata*) cocoons, exhibit transparent films covering the larval integument. Based on topochemical tests, high-performance polarization microscopy (Figure), and infrared microspectroscopy, a lipid nature was revealed for these films. The infrared spectral analysis, particularly, suggests a wax composition for such coverings, resembling the waxes used as construction materials in the honey cells produced by social bees. Considering that these larvae develop under arid environmental conditions, their covering films may have evolved as protection against water depletion. This hypothesis seems especially appropriate for *H. rhodocerata* larvae, which are capable of undergoing a 5-year-long diapause period in the absence of a protective cocoon.



Unstained wax fragment of the integumental covering from a nonsocial bee larva (*Hesperapis rhodocerata*) as observed using high-performance polarization microscopy. The different colors were obtained when a first-order red compe fornsator was introduced in the microscope slot revealing the variably oriented distribution of the covering elements.