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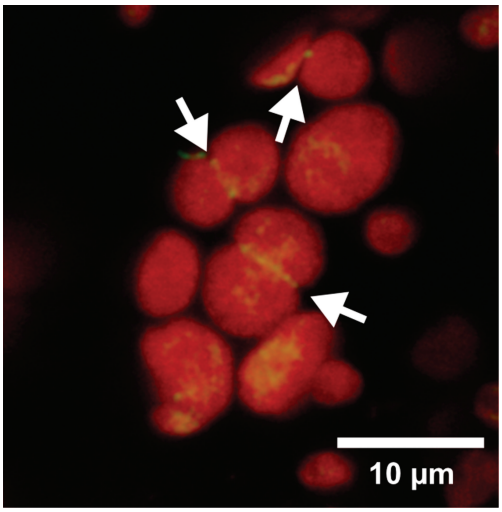
Highlights from Microscopy AND Microanalysis

Best Biological Applications Paper 2016

FtsZ1/FtsZ2 Turnover in Chloroplasts and the Role of ARC3 by CB Johnson, R Shaik, R Abdallah, S Vitha, and A Holzenburg, *Microsc Microanal* 21 (2015) 313–23

Chloroplasts are the powerhouse organelles that host photosynthesis and other processes essential for plant life. When cells divide, chloroplasts also have to divide so that the correct number of chloroplasts per cell is maintained. This division is initiated by assembling a specific protein (called FtsZ) into filamentous and then ring-like structures (Z-rings) at the middle of the chloroplast. The Z-ring then recruits additional components that cause the ring and the chloroplast to constrict, leading ultimately to the formation of two daughter chloroplasts. The Z-ring is thus a dynamic structure, the functioning of which depends on the concerted action of a range of proteins that interact with the Z-ring by binding to it and then leaving the ring again. The same is true for the basic building block of the ring, FtsZ. This coming and going of FtsZ is called FtsZ turnover. Here we describe an analysis of FtsZ turnover and how it depends on the presence of a protein that negatively affects Z-ring formation, ARC3. The question was: does ARC3 inhibit FtsZ assembly, or does it cause disassembly of existing FtsZ filaments? We found that in the presence of ARC3, GFP-labled FtsZ turnover was 3-fold faster than when ARC3 was absent, indicating that ARC3 promotes disassembly of existing FtsZ rings and filaments.

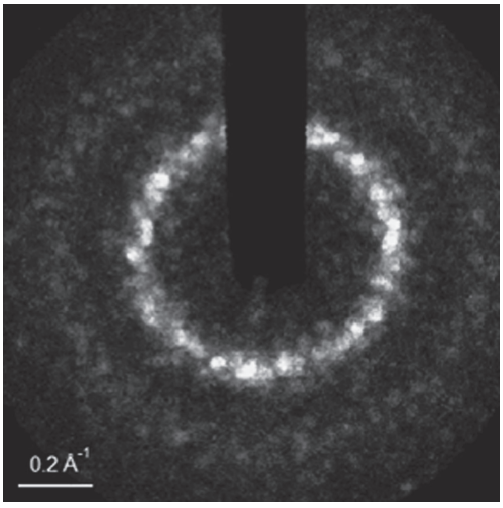


GFP-labeled FtsZ in *Arabidopsis* leaf chloroplasts with the Z-rings shown in green (and yellow) at different stages of constriction. Chloroplasts are outlined by chlorophyll autofluorescence (red).

Best Materials Applications Paper 2016

Electron Correlation Microscopy: A New Technique for Studying Local Atom Dynamics Applied to a Supercooled Liquid by L He, P Zhang, MF Besser, MJ Kramer, and PM Voyles, *Microsc Microanal* 21 (2015) 1026–33

The atoms in a liquid move around continuously but not entirely randomly. Atoms can move through liquids in chains or form cages, trapping other atoms inside. Groups of atoms come together, stick to one another for some time, and then break part. The characteristic time atoms stay in one configuration in the liquid is called the structural relaxation time. Electron correlation microscopy (ECM) is a technique for measuring the structural relaxation time with nanometer spatial resolution using nanodiffraction (see figure). A group of atoms in the liquid creates a "speckle" in the diffraction pattern. The speckle persists as long as the atomic grouping persists, so the lifetime of many speckles is a measure of the structural relaxation time. Measurements of this type were first performed with laser light (photon correlation spectroscopy), and then with synchrotron x-rays (x-ray photon correlation spectroscopy). ECM offers higher spatial resolution and higher signal for atomic liquids. This paper reports the first application of ECM to a metallic glass alloy, heated above the glass transition to a super-cooled liquid inside the microscope. The structural relaxation time follows an Arrhenius dependence on temperature and is in reasonable agreement with non-spatially resolved measurements from other techniques.



Electron nanodiffraction pattern from a $Pd_{40}Ni_{40}P_{20}$ metal liquid. The variation in time of the disk-shaped speckle in a time-series of patterns like this one contains information about the characteristic structural relaxation time of the liquid.

Microscopy AND Microanalysis

Best Instrumentation Paper 2016

Accurate Nanoscale Crystallography in Real-Space Using Scanning Transmission Electron Microscopy by JH Dycus, J S Harris, X Sang, CM Fancher, SD Findlay, AA Oni, T E Chan, CC Koch, JL Jones, LJ Allen, DL Irving, and JM LeBeau, *Microsc Microanl* 21 (2015) 946–52

Scanning transmission electron microscopy (STEM) provides atomic scale insights into the behavior of materials. Using STEM to determine bond distances without a reference in the same image is hampered by sample drift and slight miscalibration of the scan system. The resulting distorted images restrict the ability to accurately relate atom spacing to local chemistry. With the recent development of revolving STEM (RevSTEM), the effects of sample drift have been nearly eliminated. By also including a new procedure to calibrate scan system distortion, bond lengths can be determined with error below 0.1%. The figure shows a Bi_2Te_3 region with lattice parameters from individual cells measured (different color boxes). This imaging procedure was applied to thermoelectric materials, Bi_2Te_3, Bi2Se3, and $Bi_2Te_{3-x}Se_x$. Using Vegard's Law, the amount of Se in the latter material was determined from lattice parameter measurements and compared to XRD and EDS, yielding agreement within 1 at%. Further, an expansion of the van der Waals gap for the alloyed sample relative to the two bulk standards was found to result from charge redistribution arising from preferential Se incorporation. These results demonstrate that atomic resolution STEM can provide accurate and precise lattice parameter data.

RevSTEM image of Bi_2Te_3 with boxes corresponding to individual unit cells and where the box color corresponds to the length of the *c* lattice parameter as it varies from 3044 to 3068 pm.