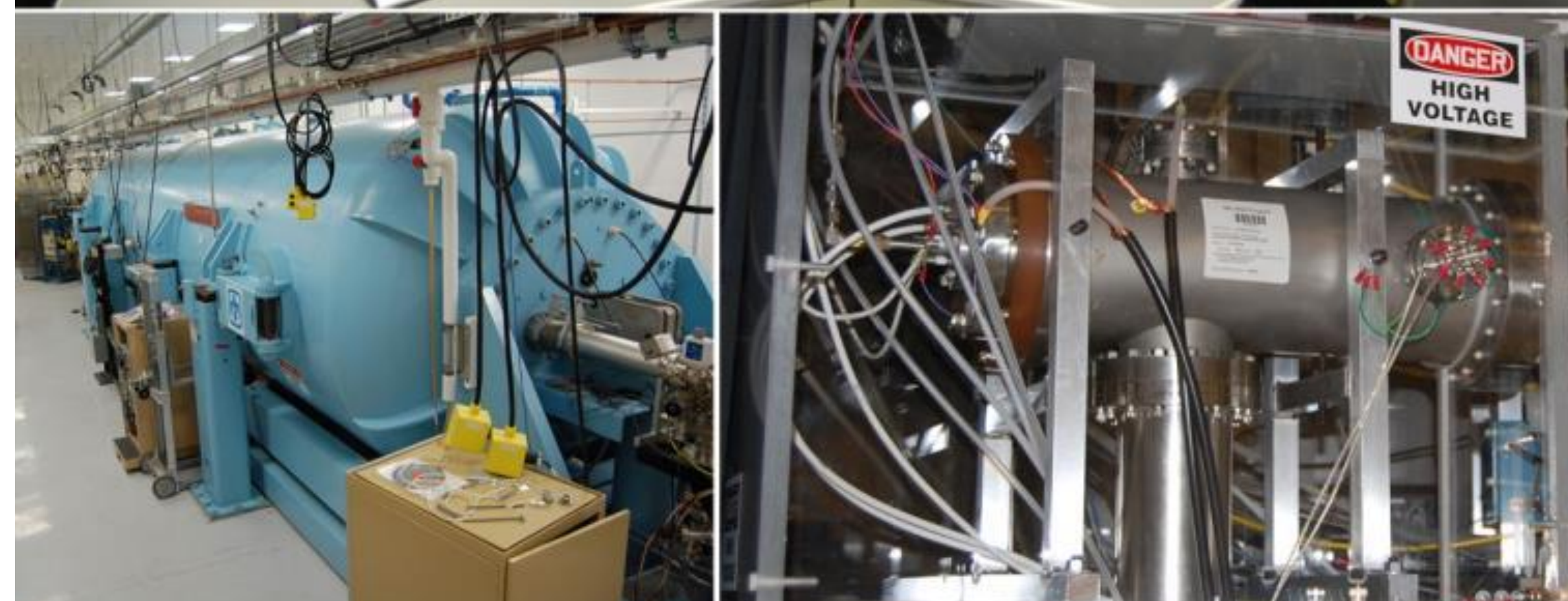
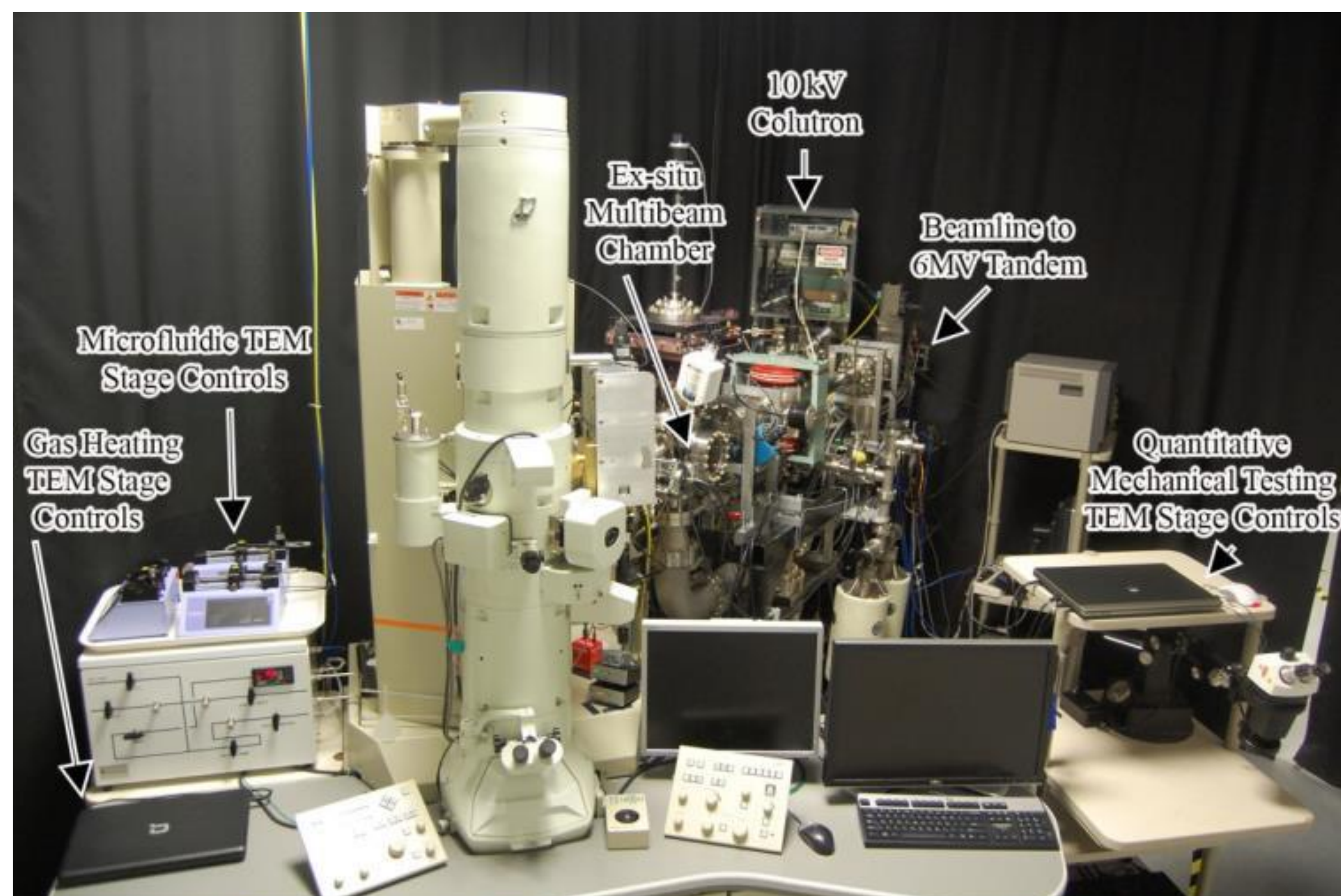


I³TEM Capabilities

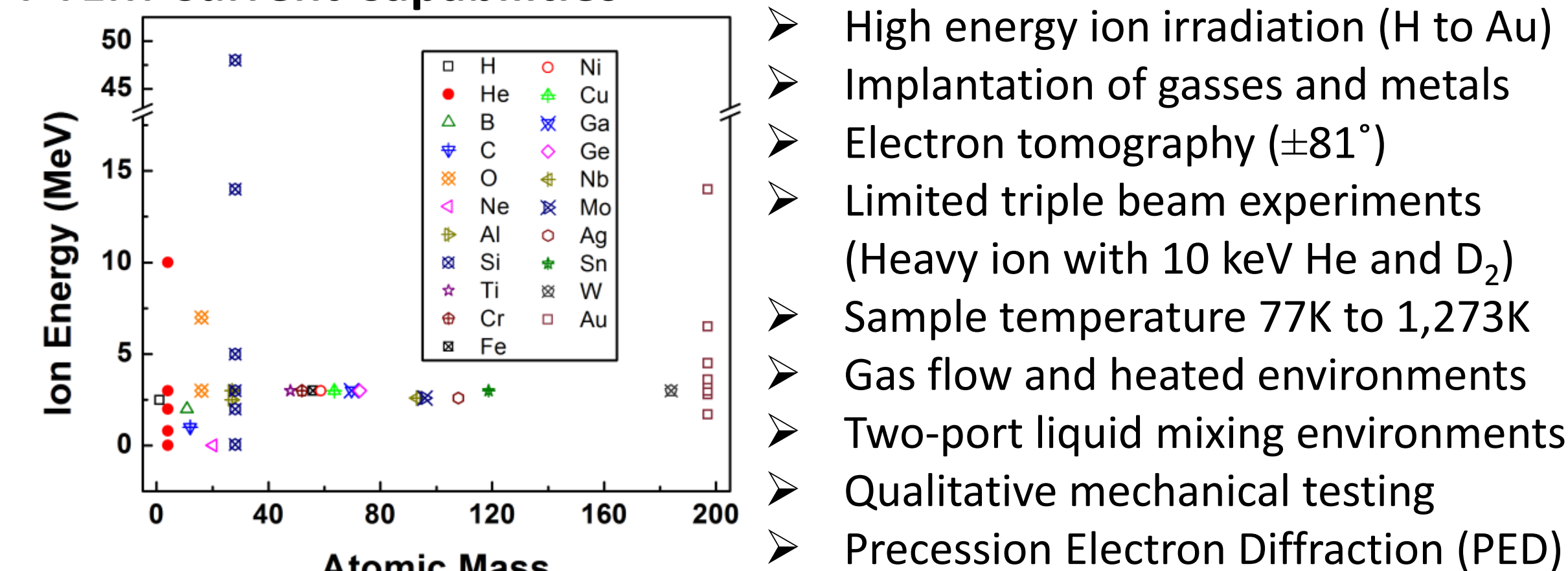
I³TEM Facility



The I³TEM combines a 200 kV TEM, a 6 MV Tandem Accelerator, and a 10 kV Cotron with a range of advanced TEM stages. Permitting both sequential, concurrent, and limited triple beam ion irradiation.

K. Hattar, D.C. Bufford, D.L. Buller, Daniel NIM:B (2014), pp. 56-65

I³TEM Current Capabilities



A plot of ion species and energies introduced into the TEM. Recently 370 eV He was introduced

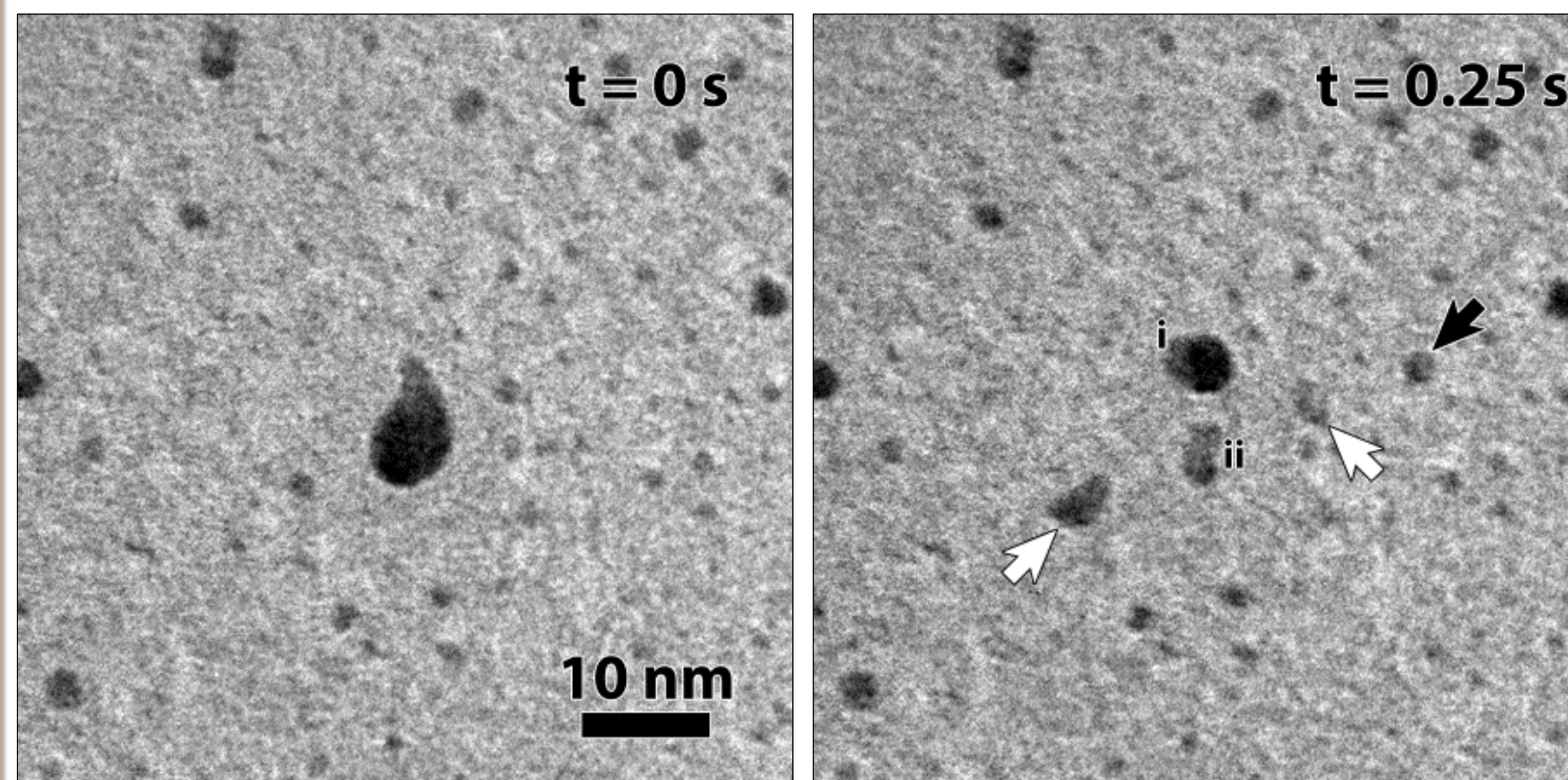
Planned Additional Capabilities

- *In situ* Cathodoluminescence (CL) and Ion Beam Induced Luminescence (IBIL)
- DTEM permitting nanosecond resolution
- Addition of a 1 MV NEC Tandem to complete the energy range
- Bending magnet upgrade to permit up to 100 MeV Au



Nanoscale Observation of Radiation Events

Single Ion Strike of 46 keV Au¹⁺ into 5 nm Au nanoparticles

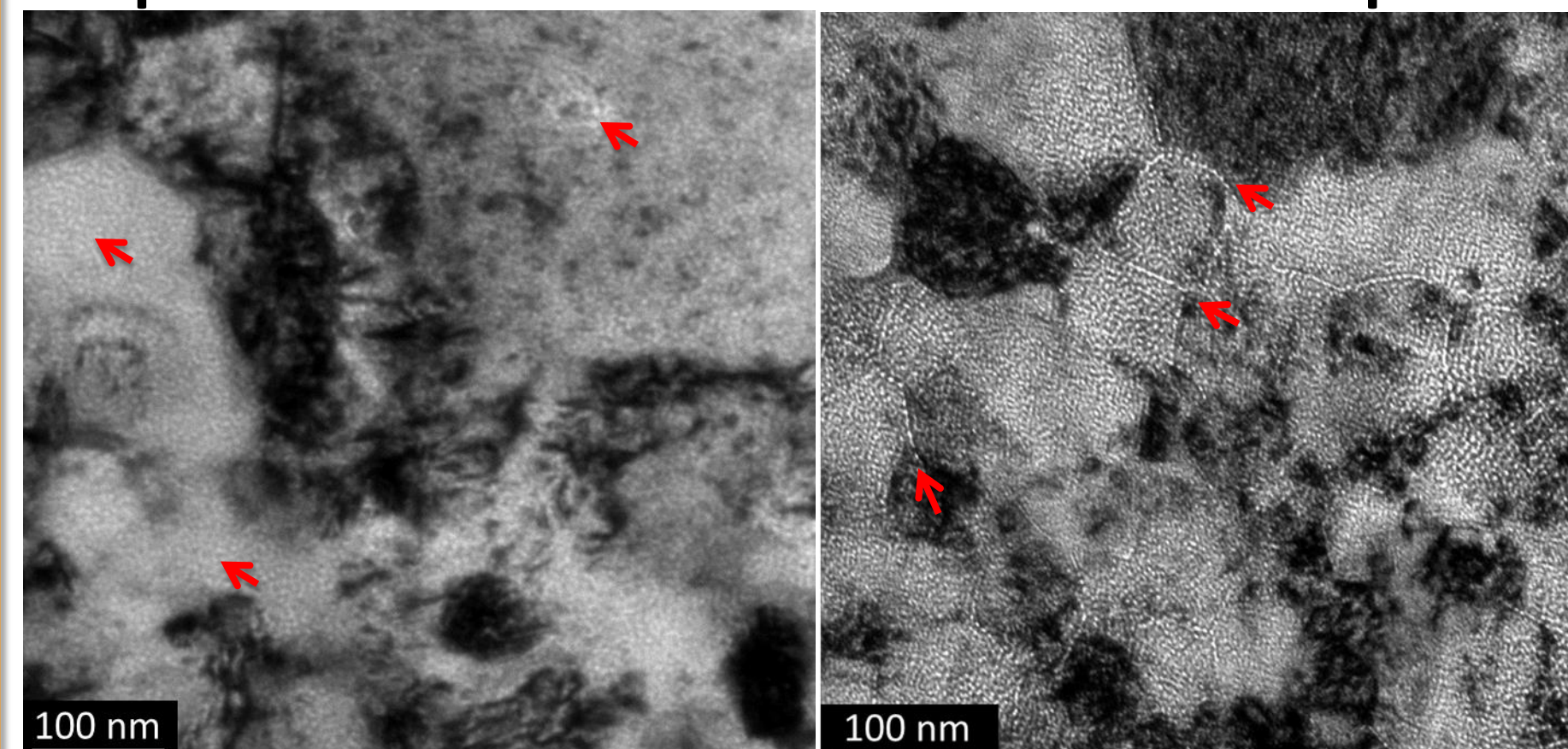


The fundamentals of radiation effects and ion beam modification can be studied in any TEM sample under a range of environments.

D.C. Bufford, S.H. Pratt, T.J. Boyle, & K. Hattar. *Chem. Commun.* 50, no. 57 (2014), pp.7593-7596.

D.C. Bufford & K. Hattar. *JMR* 29:20 (2014): 2387-2397.

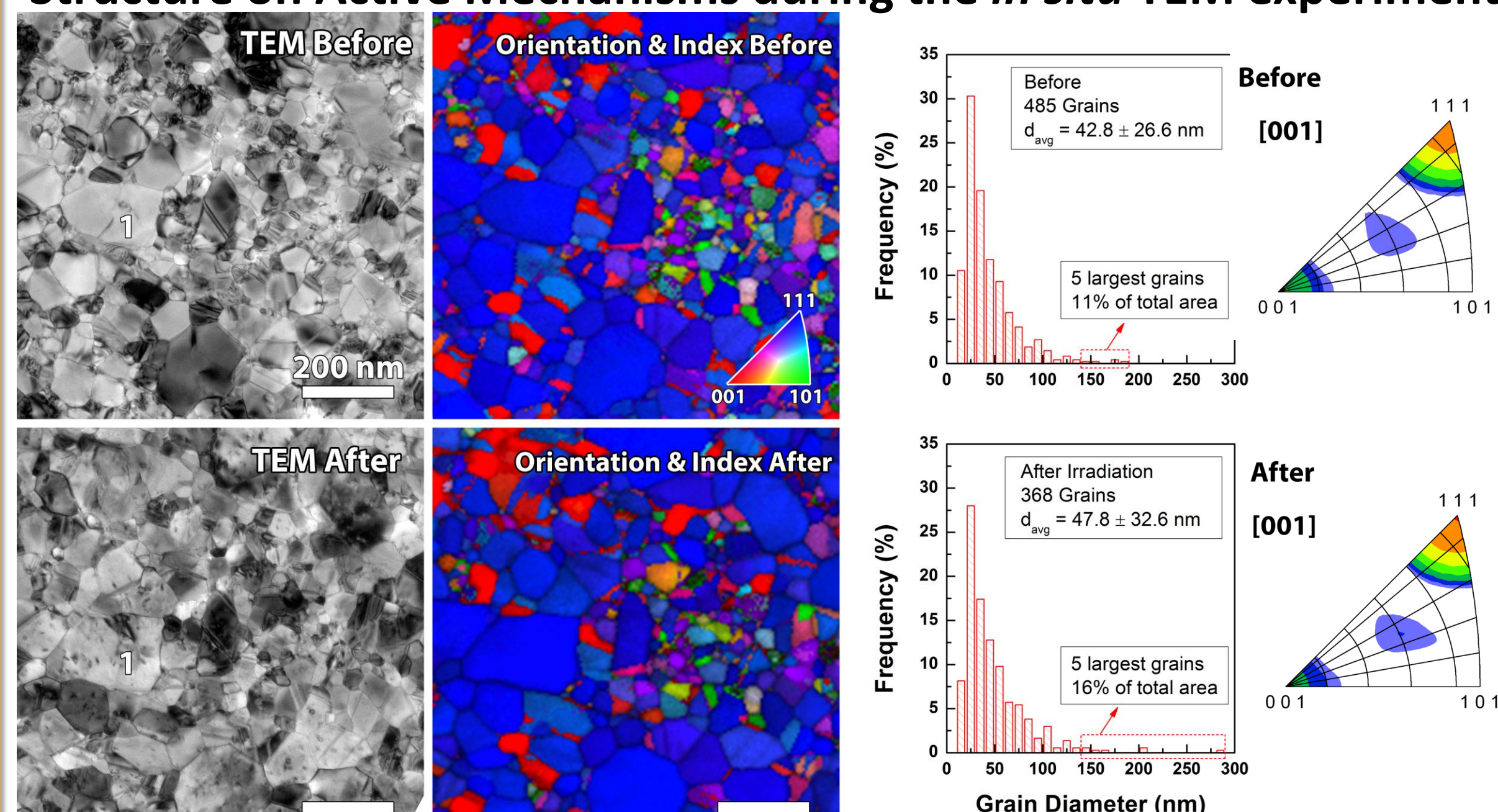
Sequential and Concurrent Effects can be Explored



Multiple accelerators permit tailoring of radiation conditions. The order of 10 keV He and 3 MeV self-ion irradiation in Ni dictates where He bubbles form.

B.R. Munfitering, et al. *MRL* (2015): 1-8.

Orientation Mapping Provides Rapid Insight into the Role of Local Structure on Active Mechanisms during the *in situ* TEM experiments



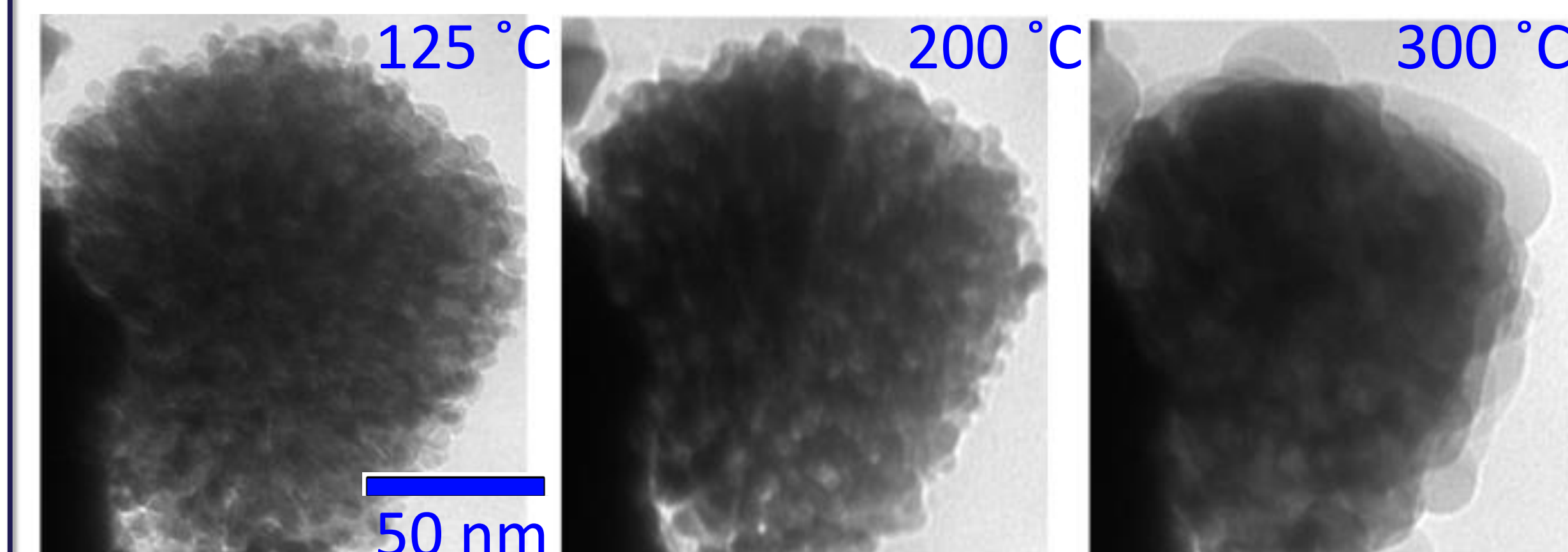
D.C. Bufford, F.F. Abdeljawad, S.M. Foiles, & K. Hattar. *APL* 107, no. 19 (2015): 191901.

Associated Team Members and Collaborators

- D.L. Buller, J.A. Scott, M.T. Marshall, R. Sisson, D.C. Bufford, and B.R. Munfitering
- Fadi F. Abdeljawad, Mark D. Allendorf, Corbette Battaille, Thomas E. Beechem III, Brad L. Boyce, Timothy J. Boyle, Darren W. Branch, Thomas Buchheit, Daniel C. Bufford, Daniel L. Buller, Jay D. Carroll, Michael Chandross, Blythe G. Clark, Remi P.M. Dingreville, F. Patrick Doty, Barney L. Doyle, Matthew Eichenfield, Patrick L. Feng, Stephen M. Foiles, David M. Follstaedt (retired), Ronald Goetz, Steven H. Goods (retired), Aaron C. Hall, Michelle A. Heikmaty, Bernadette A. Hernandez-Sanchez, Sara J. Homeier, Jon F. Ihlefeld, James A. Knapp (retired), Paul G. Kotula, Jonathan Madison, Douglas L. Medlin, Joseph Michael, William M. Mook, Tina M. Nenoff, Roy H. Olsson III, Henry A. Padilla II, Edward S. Piekos, S. V. Prasad, Sarah H. Pratt, Joseph D. Puskar, David B. Robinson, Mark A. Rodriguez, Pylis Sarobol, Darryl Y. Sasaki, Peter A. Sharma, Vitalie Stavila, Vina Tikare, Gyorgy Vizelethy, Michael Wiwi, Pin Yang, and Jonathan A. Zimmerman
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Additional Extreme Environments

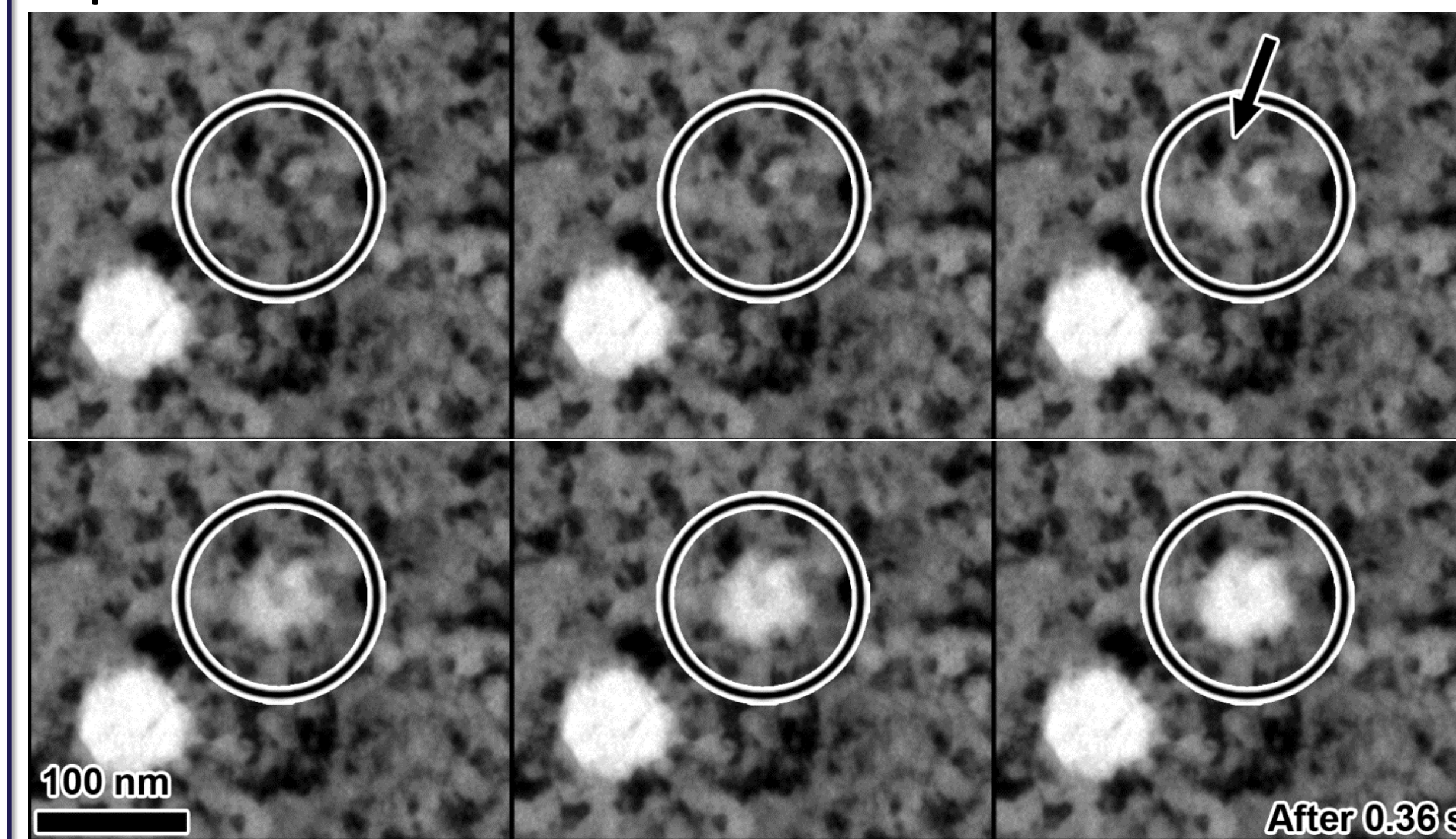
Gas Environments



The response of nonporous Pd nanoparticles were explored as a function of temperature and H₂ gas pressure. Pore collapsed significantly lower temperature than when annealed in vacuum.

P.J. Cappillino *J. Mat. Chem. A* 1, no. 3 (2013): 602-610.

Liquid Environments

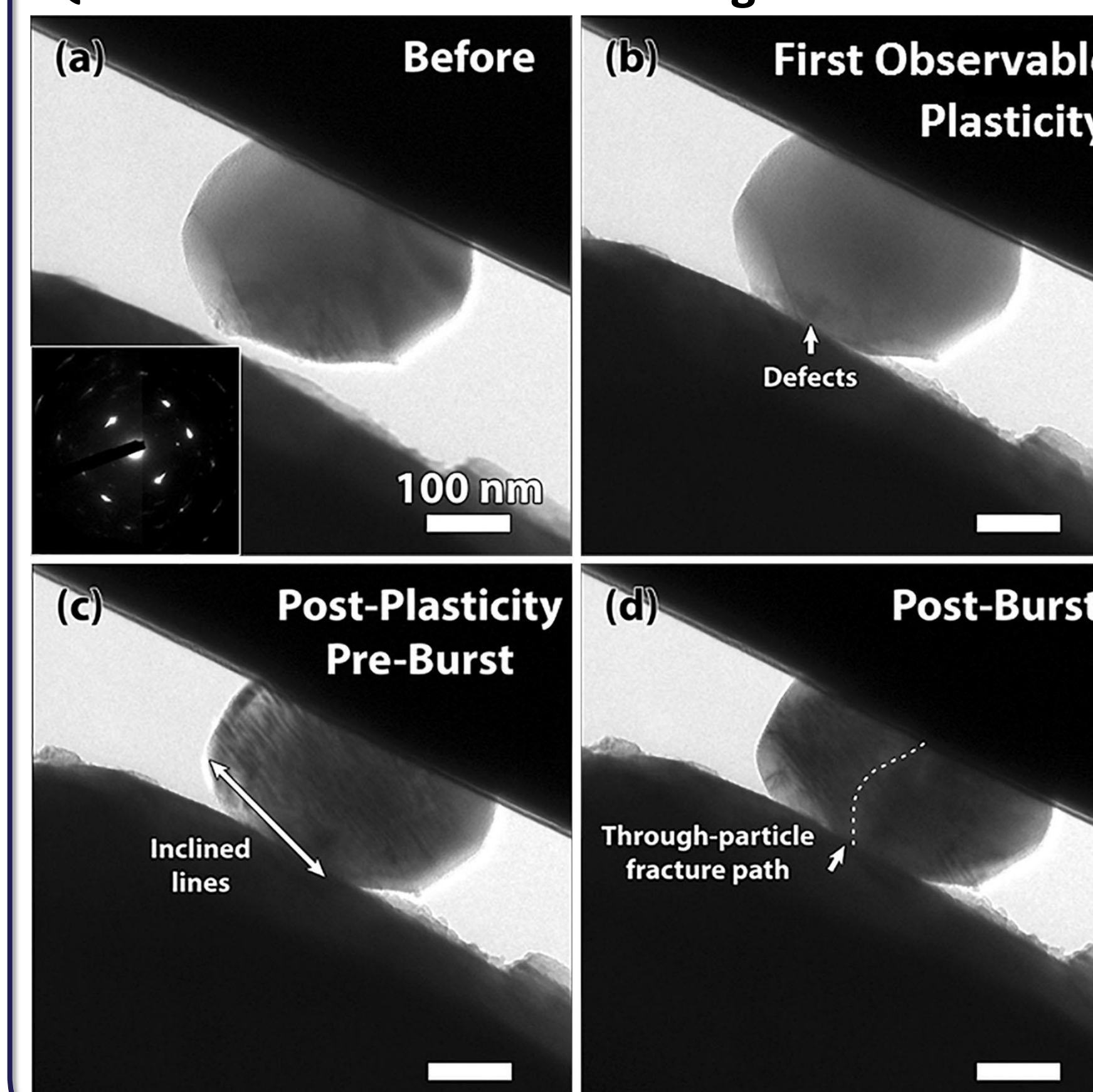


Nanoscale insight into liquid-solid interactions can be probed through in situ microfluidic TEM experiments. Here, pitting initiation is investigated in nanocrystalline Fe exposed to acetic acid.

Kacher et al. unpublished

S.W. Chee, et al. *Chem. Commun.* 51, no. 1 (2014): 168-171.

Quantitative Mechanical Testing



Quantitative mechanical measurement during in situ TEM observation permits direct correlation between the structural evolution and the mechanical properties. Here, the deformation and failure of Al₂O₃ nanoparticles can be directly observed.

P. Sarobol, et al. *J. Thermal Spray Technology* 25, no. 1-2 (2016): 82-93.