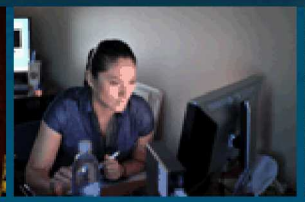
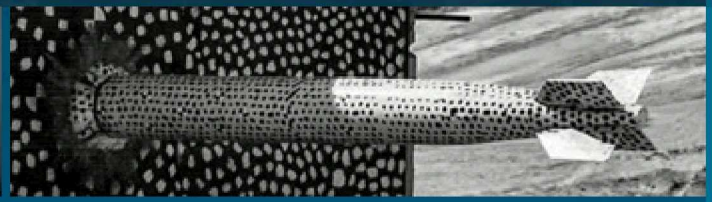
This paper describes objective technical results and analysis. Any subjective views or opinions that might be expressed in the paper do not necessarily represent the views of the U.S. Department of Energy or the United States Government.

SAND2020-10120C

In-situ Characterization of Nanomaterials in Extreme Environments with the I³TEM





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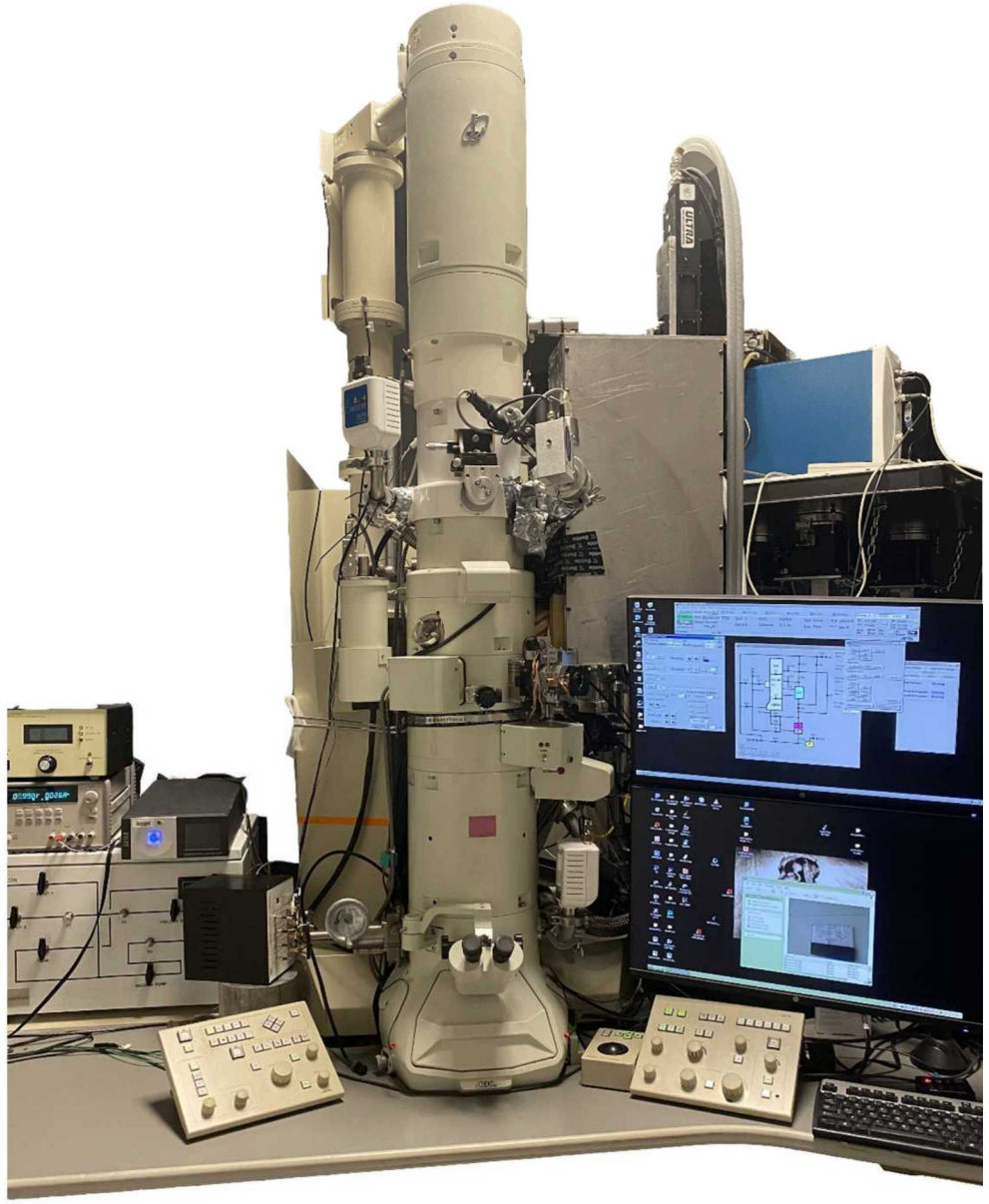
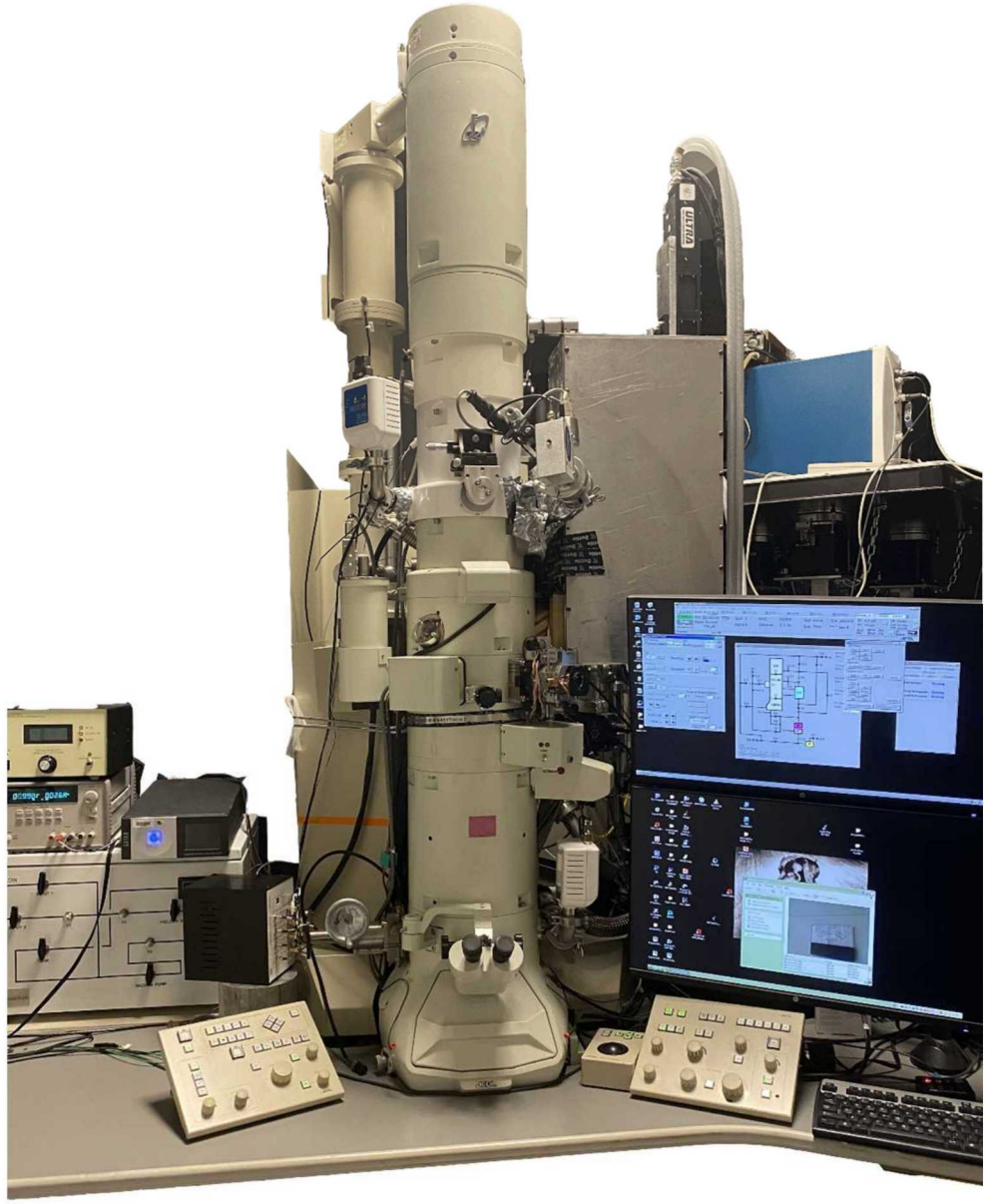
Tools of the I³TEM

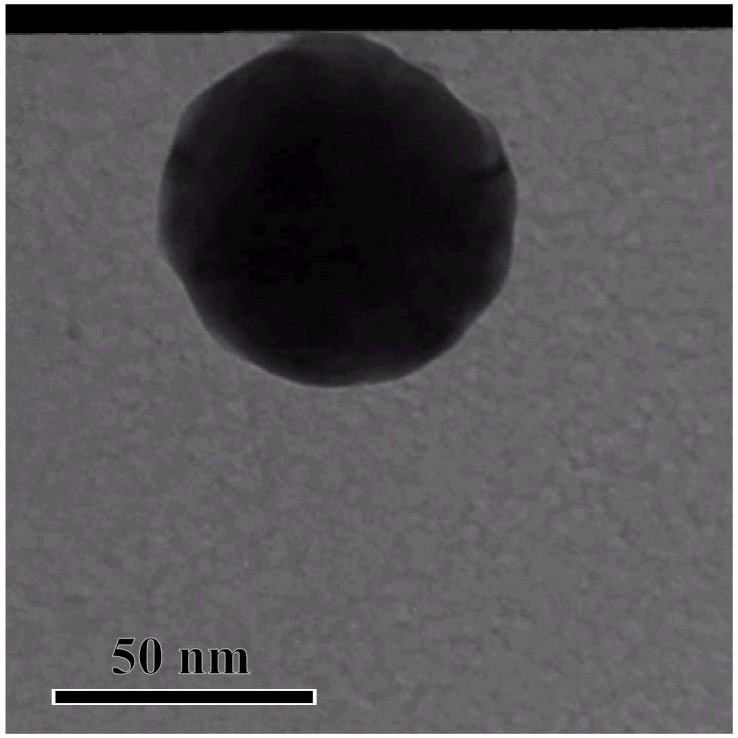


In-situ Ion Irradiation TEM (I³TEM)

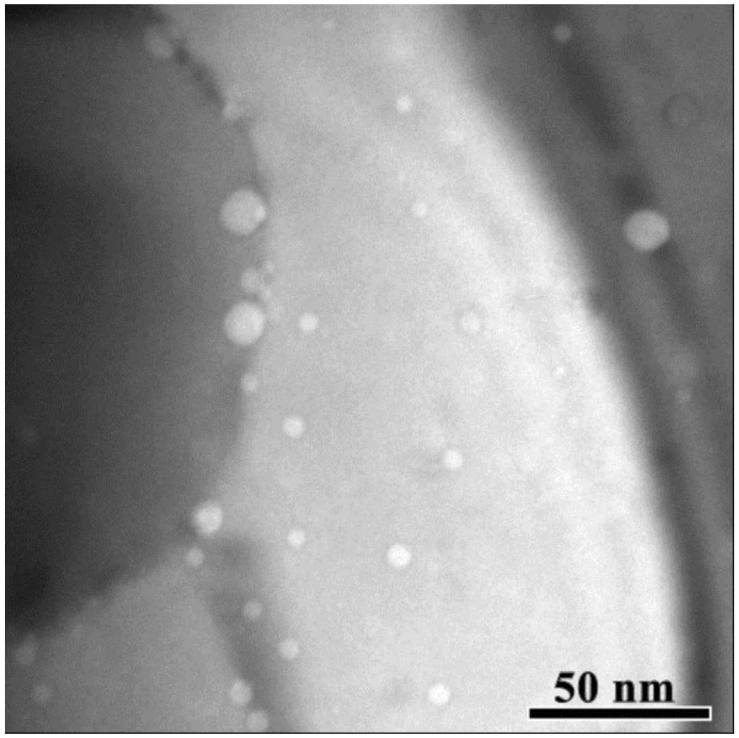
- Modified JEOL 2100-LaB_6 TEM
- Well suited for exploring materials in extreme environments
  - Multibeam ion irradiation
  - Laser heating
  - Dynamic imaging
  - In-situ spectrometry
  - Nanomechanical testing platforms
  - 27 different TEM holders (heating, cooling, gas cell, liquid cell, bias, etc.)
  - Nanomegas ASTAR automatic crystallographic orientation mapping system (~8 nm spatial resolution)
  - Direct Electron DE-16 4K camera (up to 4000 fps video)

Ion Irradiation Capabilities



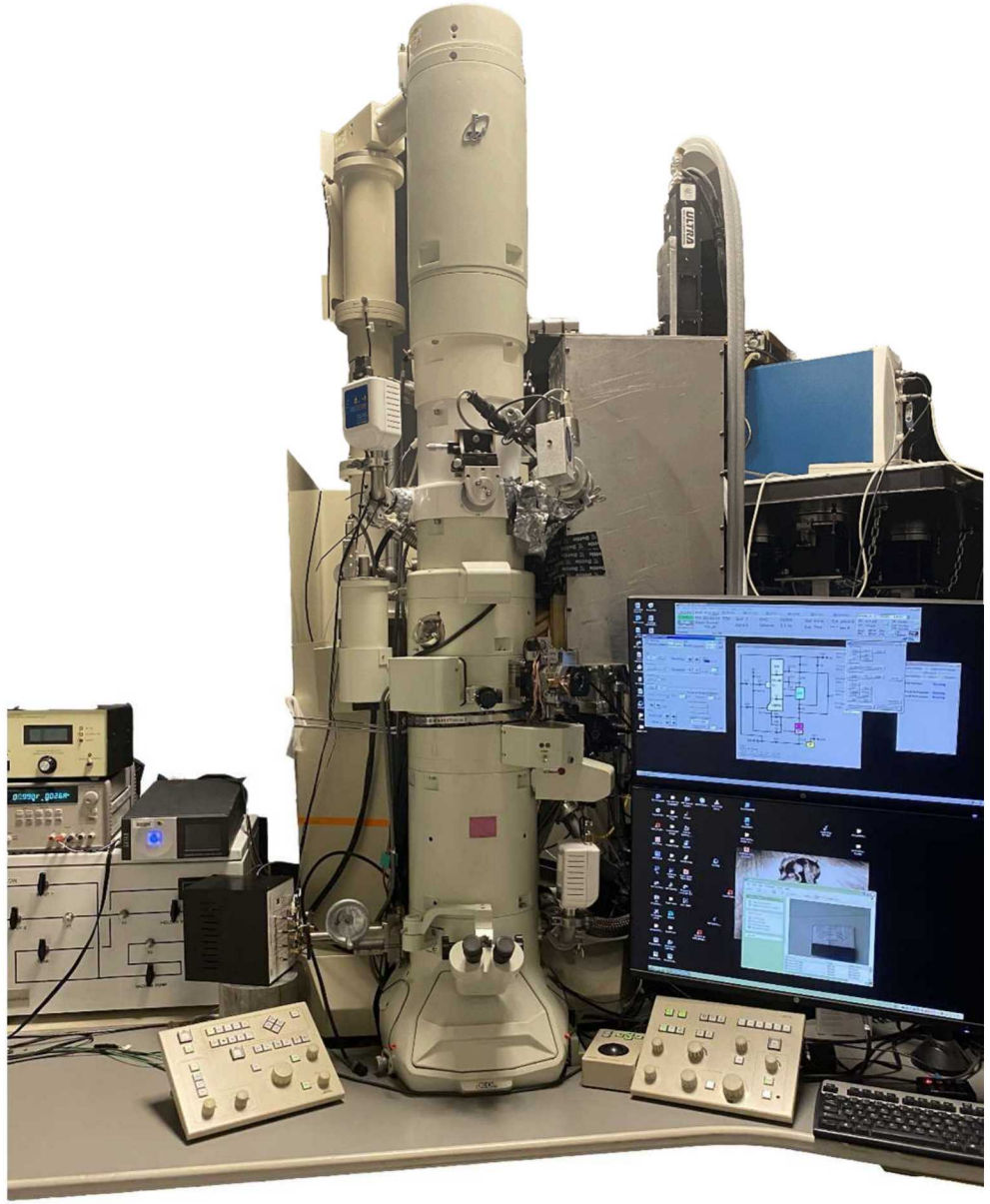


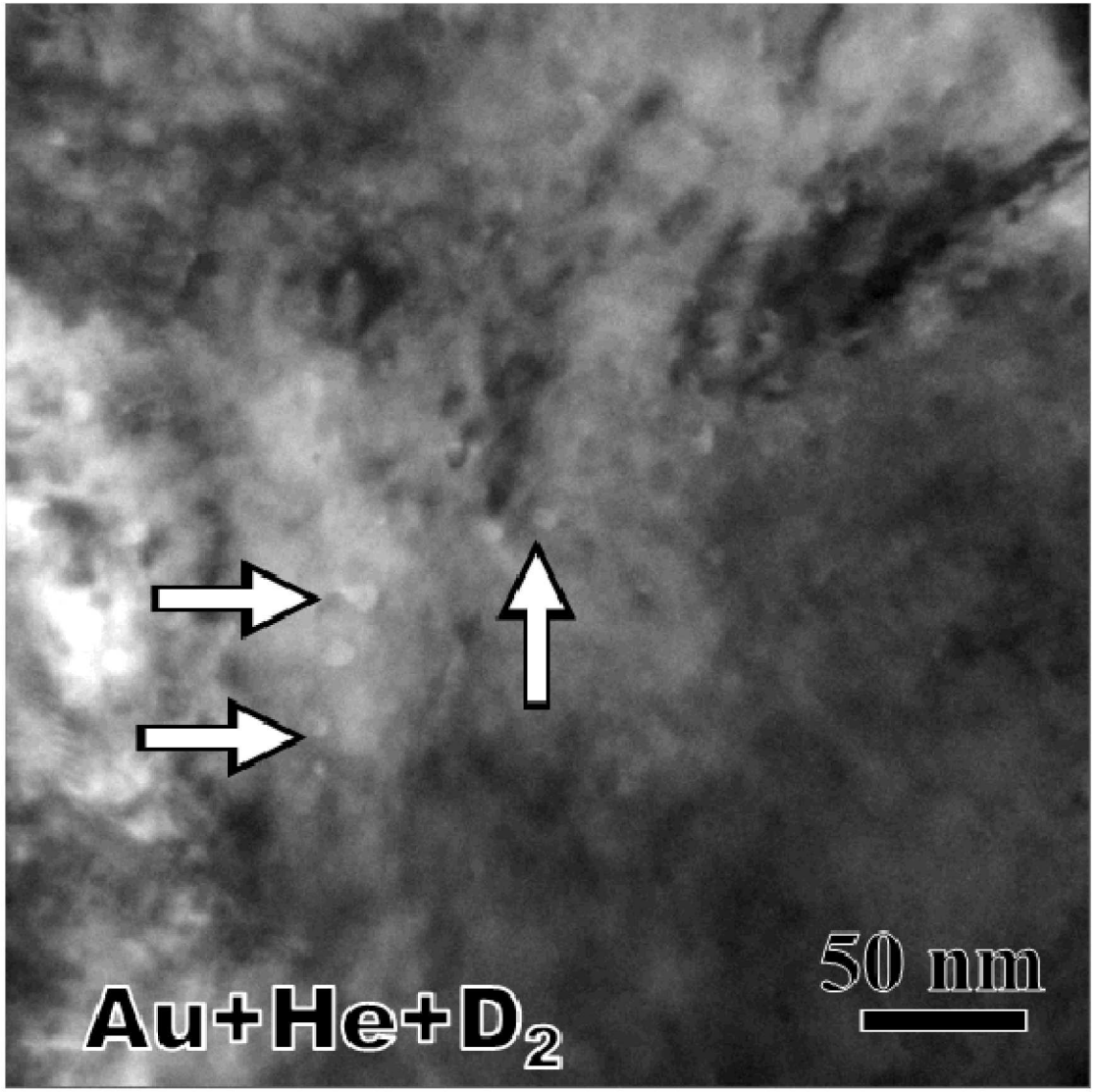
Au nanoparticle irradiated with 2.8 MeV Au



He bubbles in Pd annealed at 700°C (Collaboration with C. Taylor, SNL/LANL)

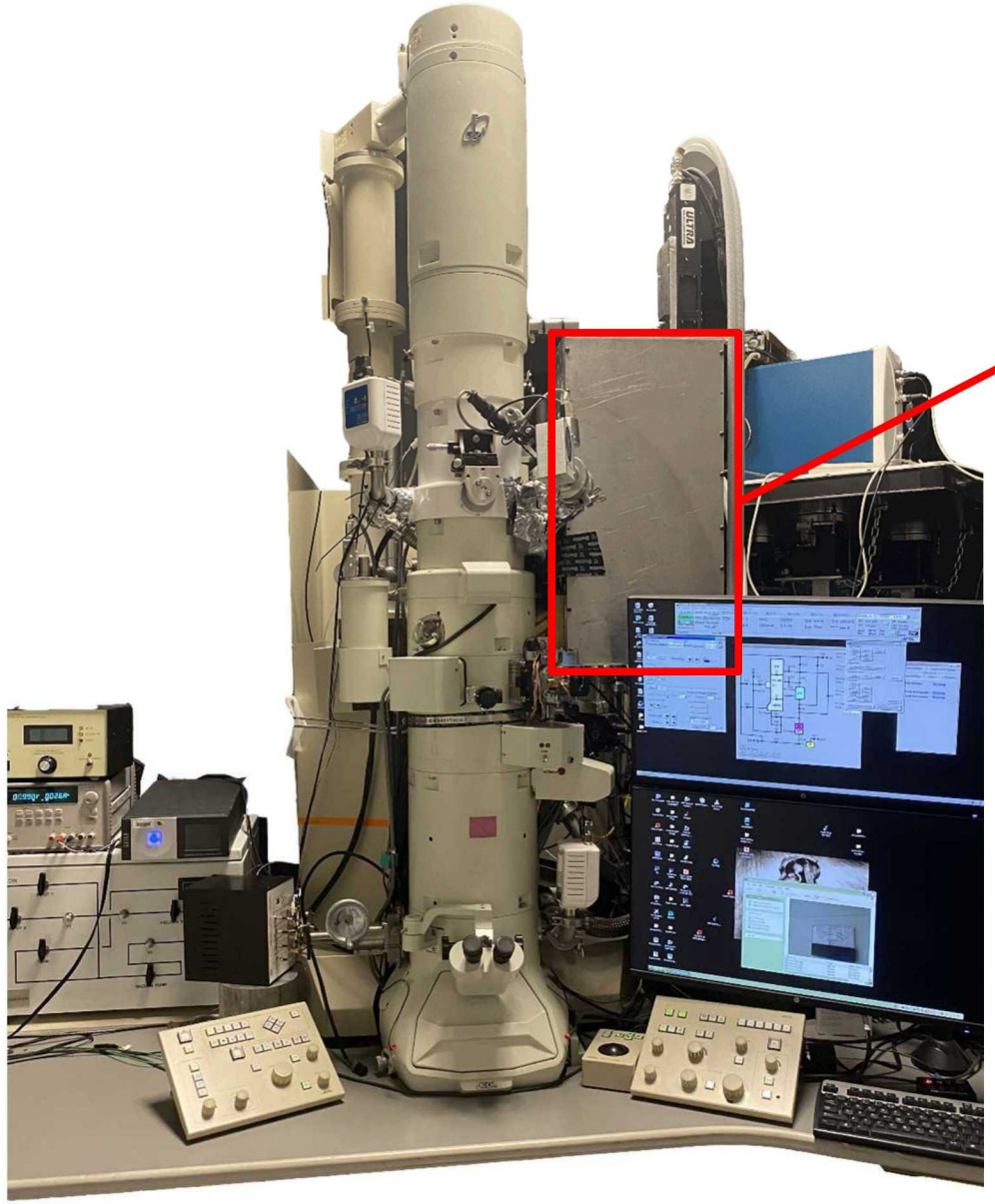
Ion Irradiation Capabilities

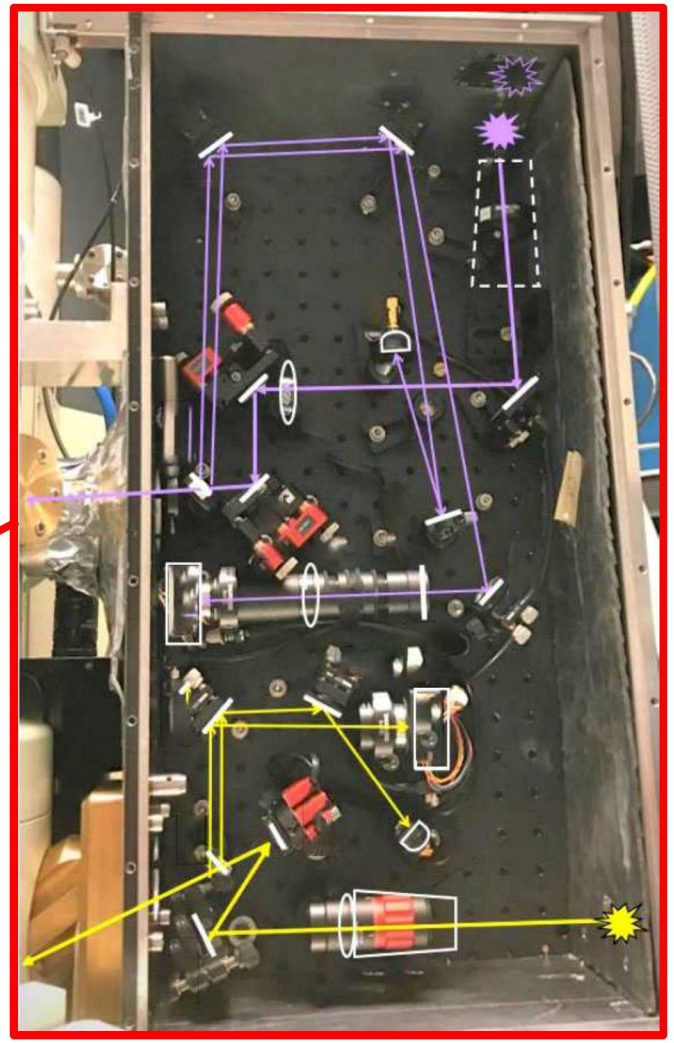




White arrows show He and D_2 bubbles in Au after simultaneous 2.8 MeV Au, 10 keV He, and 10 keV D_2 irradiation.
(Collaboration with D. Bufford, SNL)

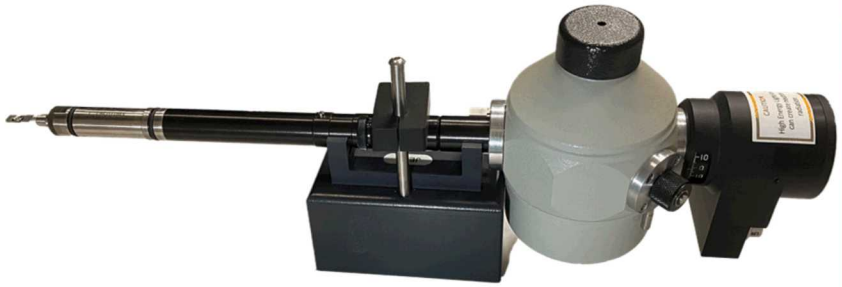
Rapid Thermal Cycling





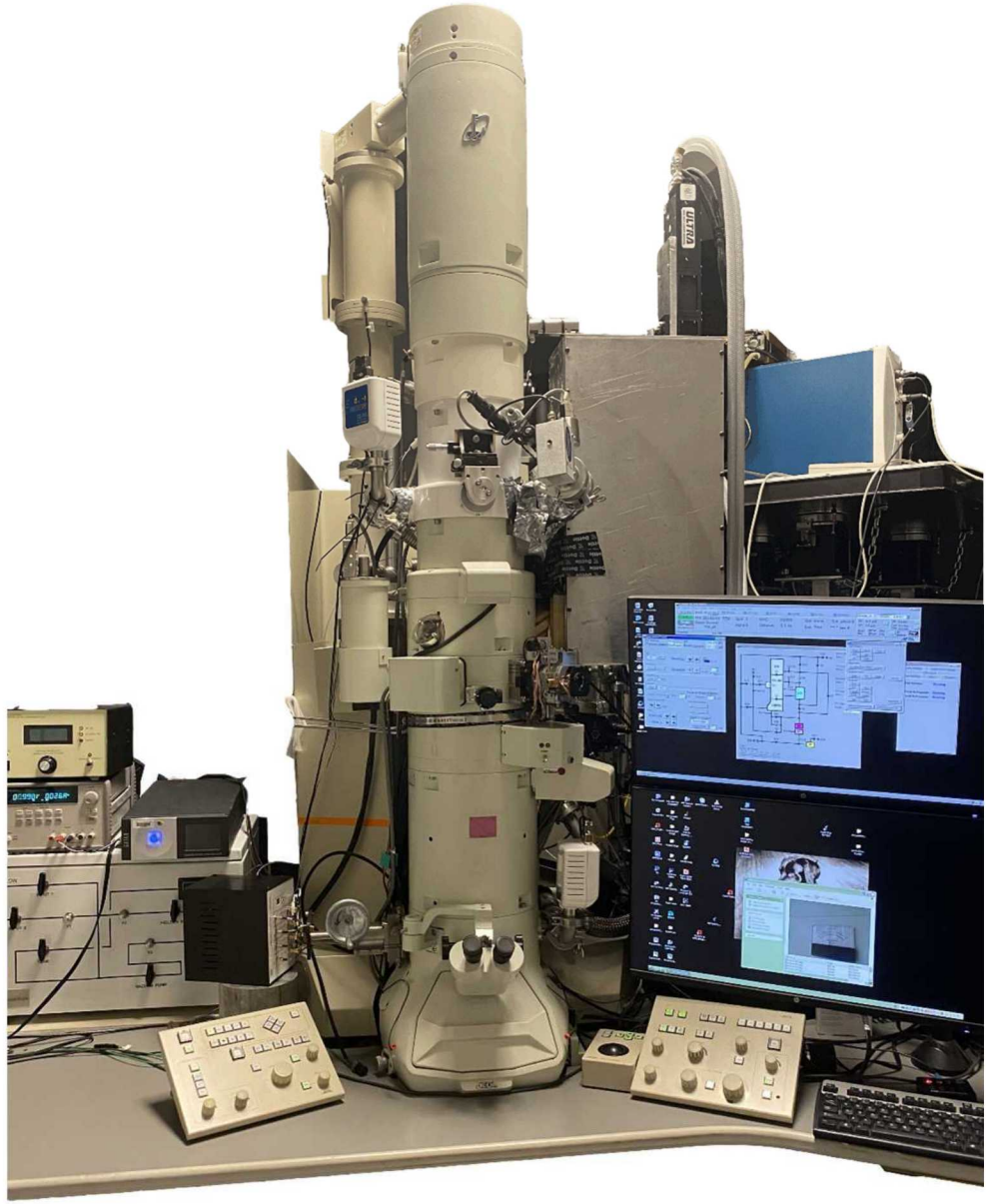
- 20 W 1064 nm IR laser for sample heating
- Have reached temps of up to 2200°C in ZrO_2

  Grosso *et al.*, Nanoletters, 20 (2), 2020.

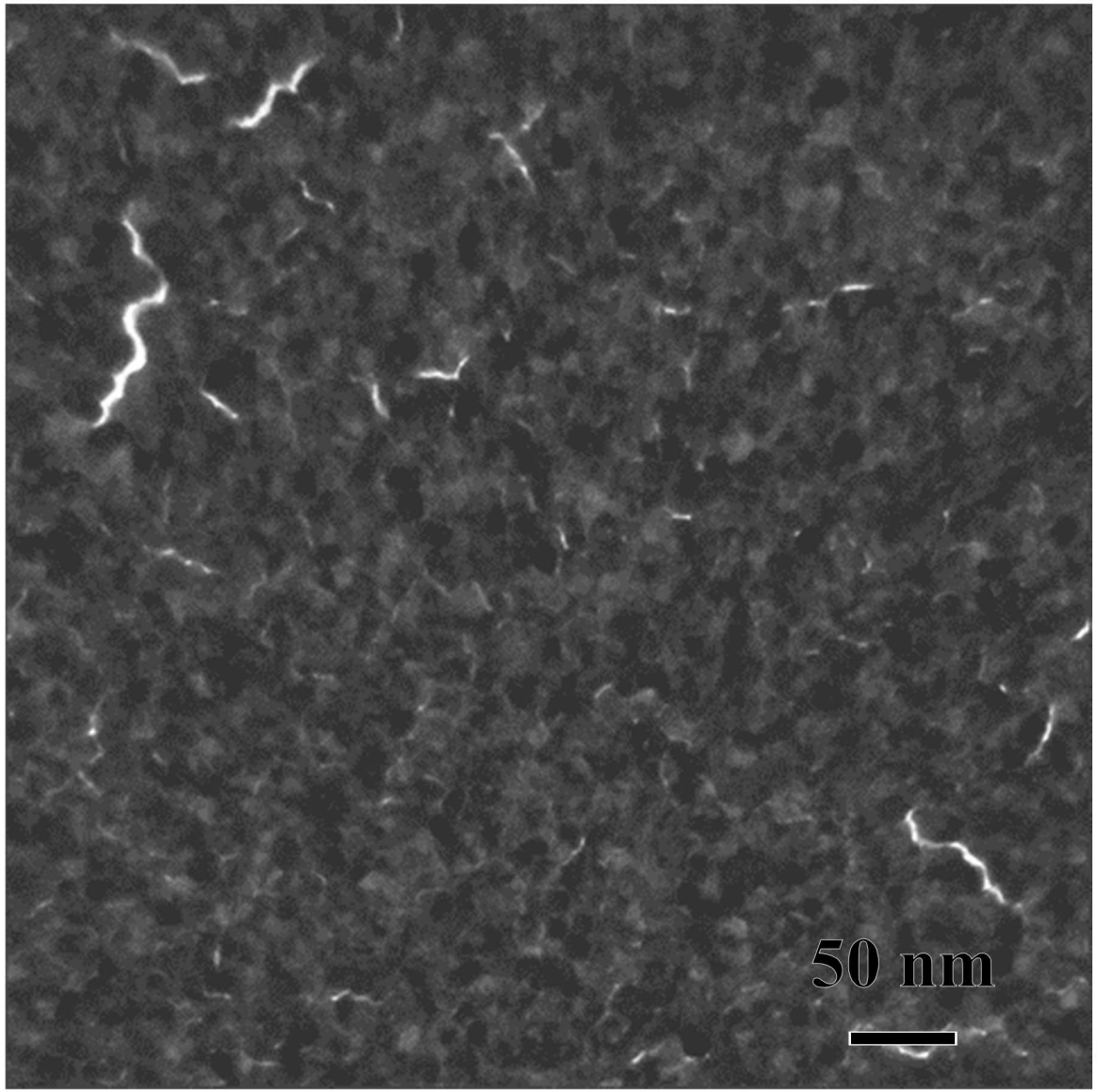


- Gatan Model 636.6 Cryogenic holder
- Can reach temperatures as low as -175°C using liquid N_2

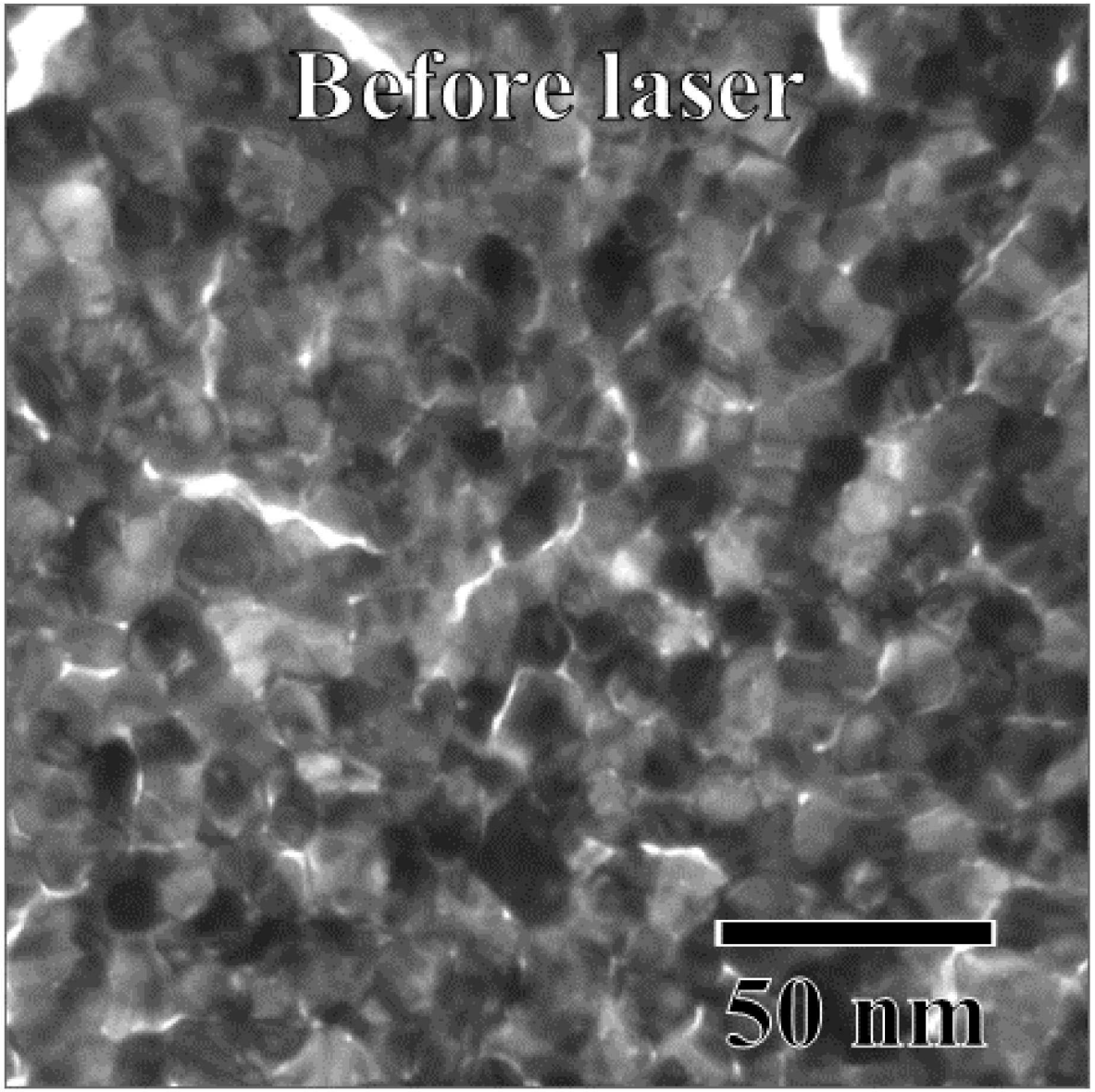
Rapid Thermal Cycling

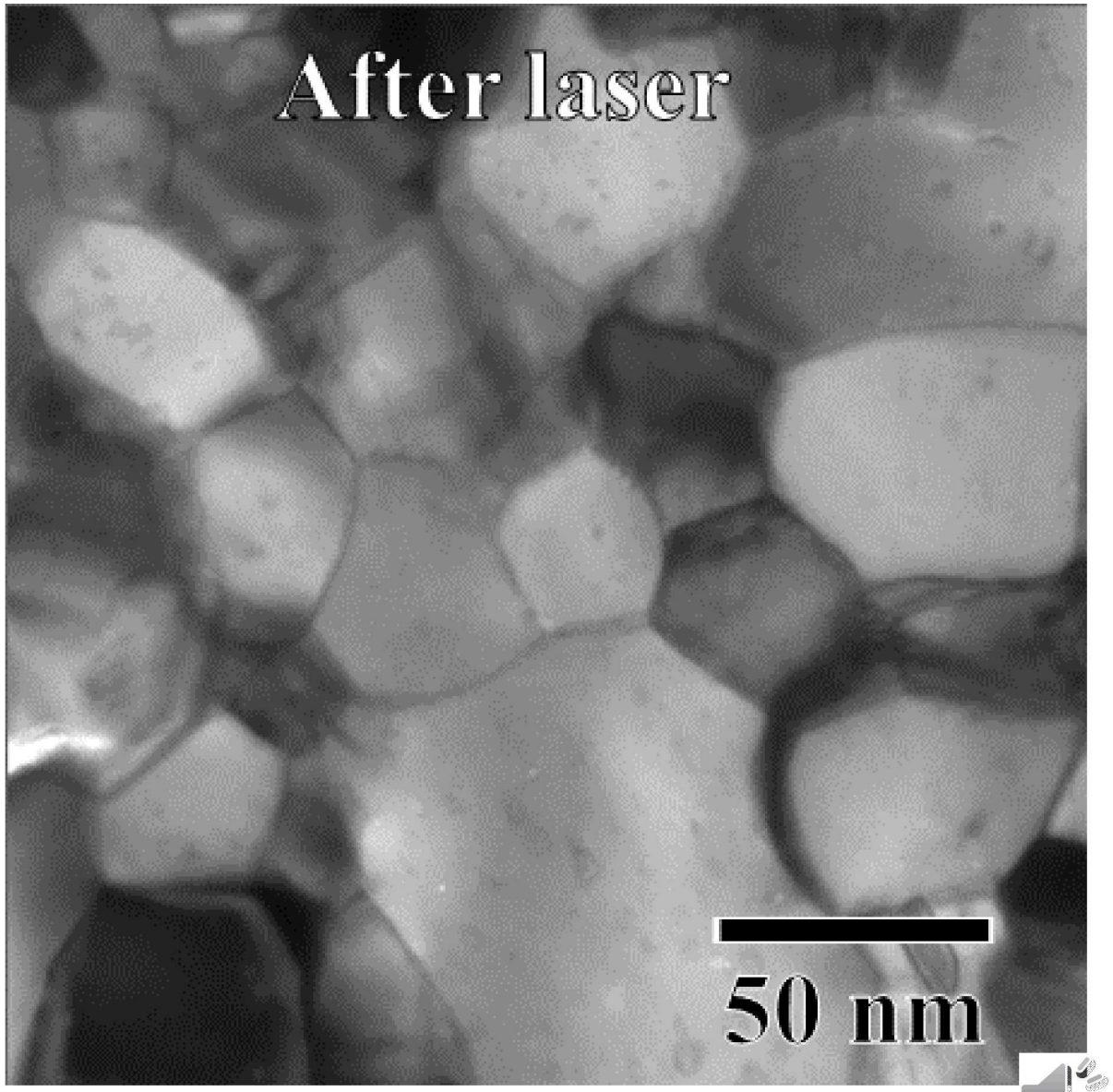


Nanocrystalline Pt film before and after 1 second laser exposure with a power density of 72 kW cm^{-2}



Rapid Thermal Cycling





Nanocrystalline Pt film before and after 1 second laser exposure with a power density of 72 kW cm^{-2}

Acknowledgements

The I^{3}TEM is available for CINT user proposals

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