



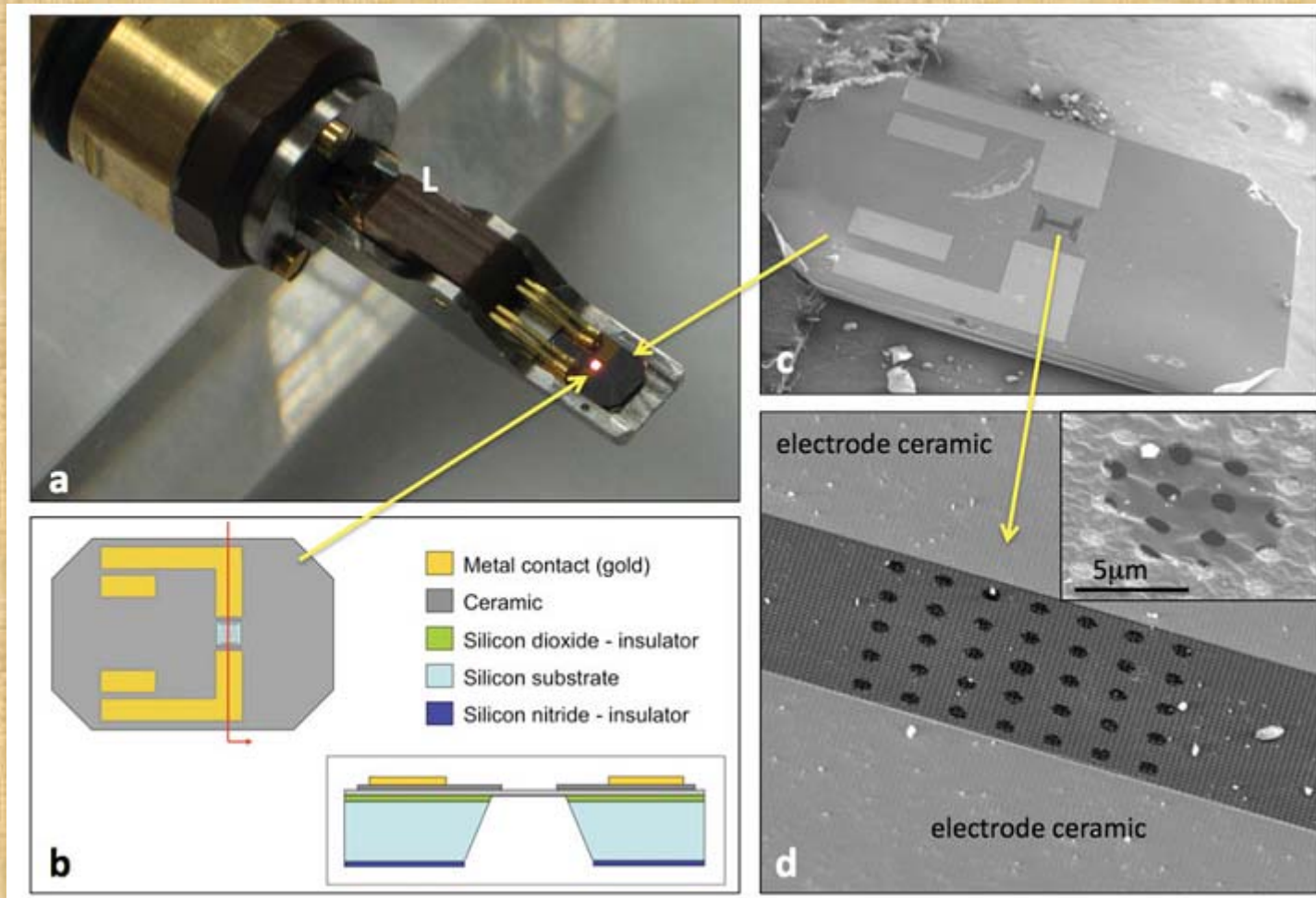
Aduro: A stable and high speed heating hot stage for *in-situ* grain boundary observation

Zhiyang Yu, M. P. Harmer

About Protochips (Raleigh, NC)

- [Aduro™](#) — Revolutionary MEMS-based holders and stages for electron microscopes that enable *in-situ* analysis at temperatures up to 1200 °C with atomic resolution.
- [Poseidon™](#)
- [C-flat™](#)
- [DuraSiN™](#).

Aduro in Lehigh_*In-situ* hot stage



Aduro@Lehigh-Specification

Temperature Range	Ambient to 1200° C +/- 0.5-3° C
Heating ramp	1000° C in a millisecond (Instantaneous heating and cooling)
Drift	Inherent drift in microscope stage (<0.5nm/min)
Current control	Programmable
Tilt	Alpha

Excellent capacity with current techniques

- Imaging: TEM, SEM(SE/BSE), Sub Angstrom Cs-corrected STEM(BF/DF)
- Analytic: EDS, EELS, WDS, EBSD, EBIC, CL, Voltage contrast
- *In situ* methods: Environmental electron microscopy

Applicable samples

- Nanoparticles
- Thin films and coating
- **FIB sections**
- Core/shell systems
- Alloys
- Liquid metals
- Nanotubes
- Discontinuous metals

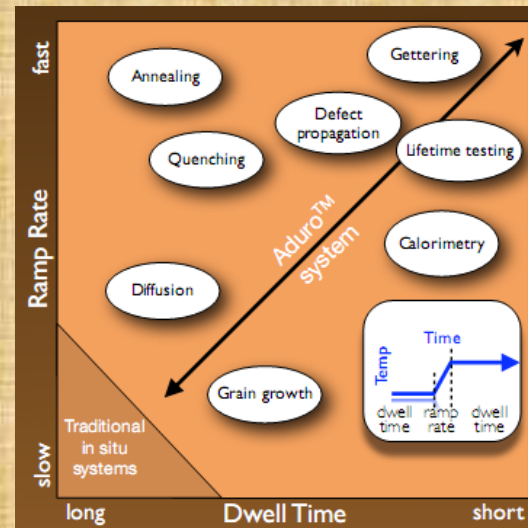


Research groups

- Larry Allard Research Group, Oak Ridge National Laboratory (JEOL 2200FS with probe corrector, In-situ heating of catalytic particles)
- Paulo Ferreira Research Group, The University of Texas at Austin (JEOL 2010F TEM, In-situ heating of small particles for the size effects)

Applications

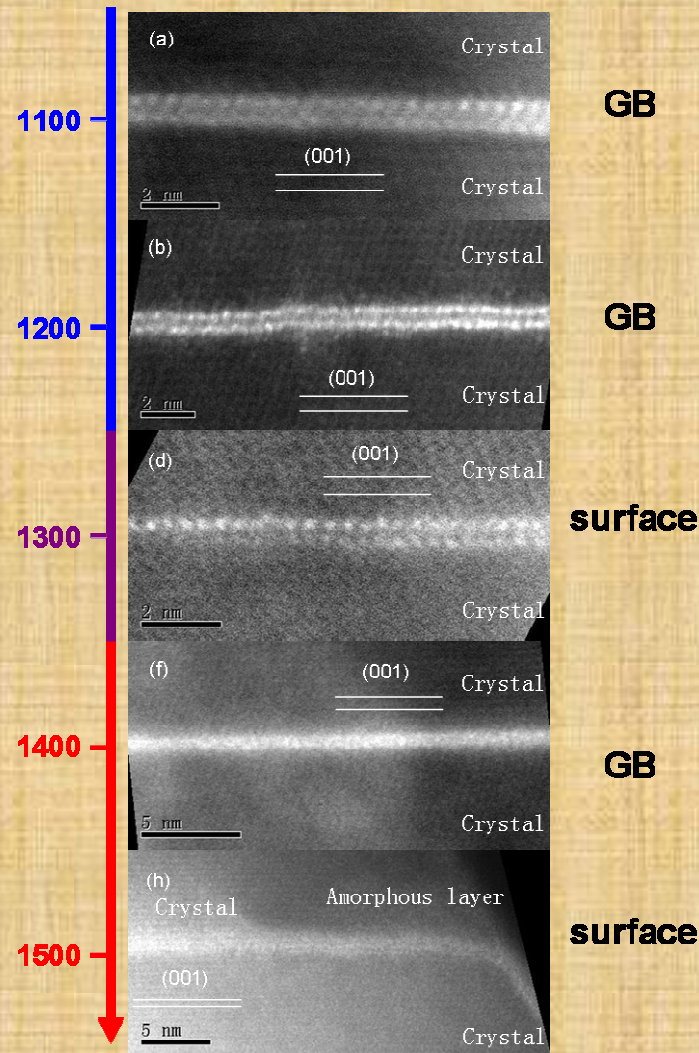
- Sintering
- Grain growth
- Phase changes
- Quenching
- Diffusion
- Dynamic reactions
- Rapid thermal annealing
- Rapid thermal cycling and lifetime testing
- Recrystallization
- Ultra-high and high temperature studies



Our future plans

- Exploring evolution of complexions with atomic resolution
- Correlating crystal growth with the transition of complexion

Example



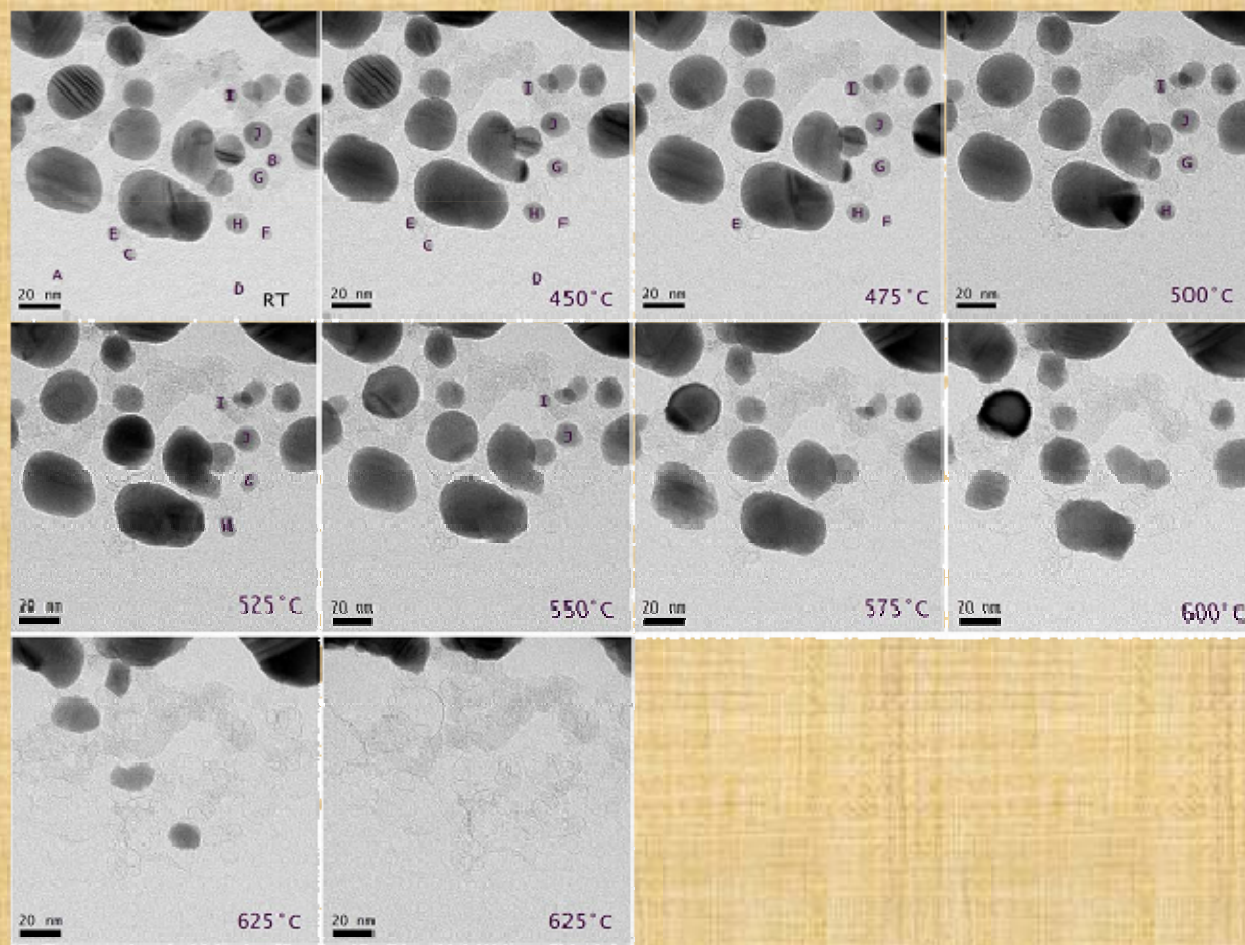
**Complexion transition
and crystal growth
in boron-rich nanowires**

Acknowledgements

- Thank Dr. Animesh Kundu for technical assistance!
- Thank Prof. Jian Luo in the discussion of boron-rich complexion!

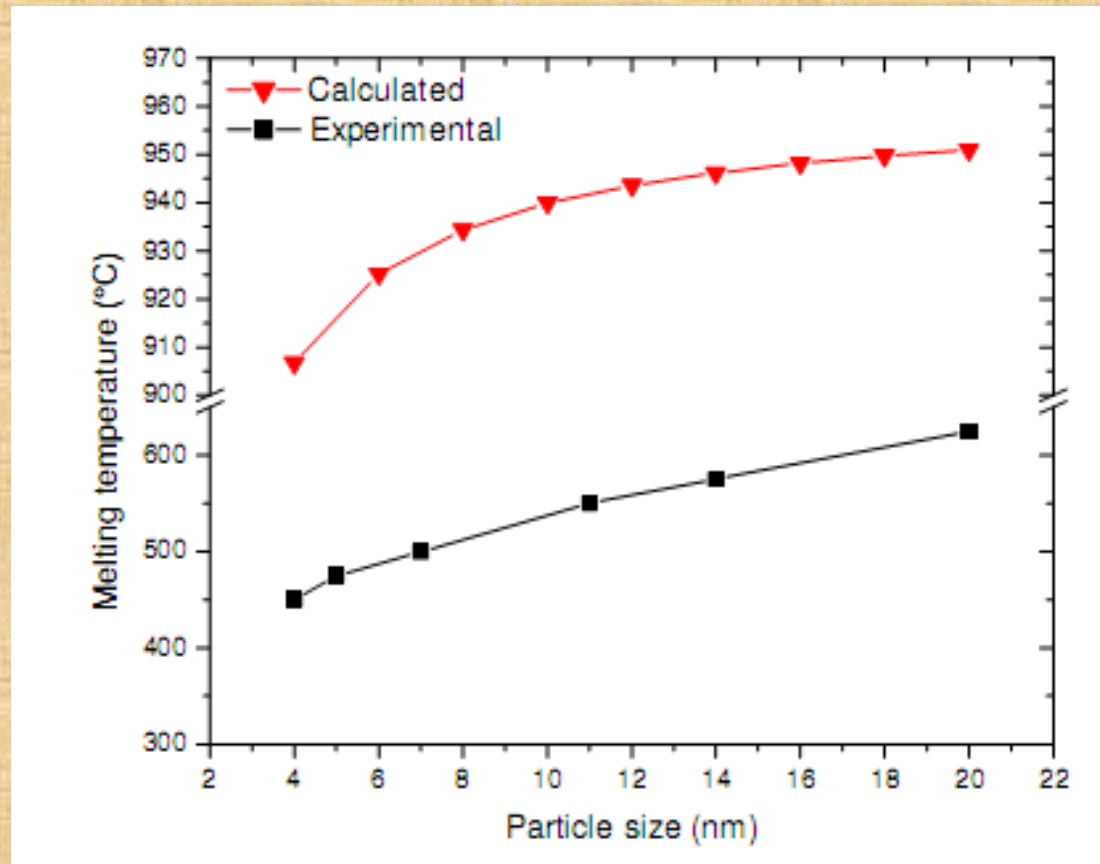
Thanks for attention!

Melting of Ag nanoparticles: A case study



In-situ observation of Ag particles at elevated temperature
Microsc Microanal. 15 (Suppl 2). 2009

Size Effects of nanoparticles



Melting temperature as a function of particle sizes