Equation of State Measurements in High-Porosity Ta_2O_5 Foam

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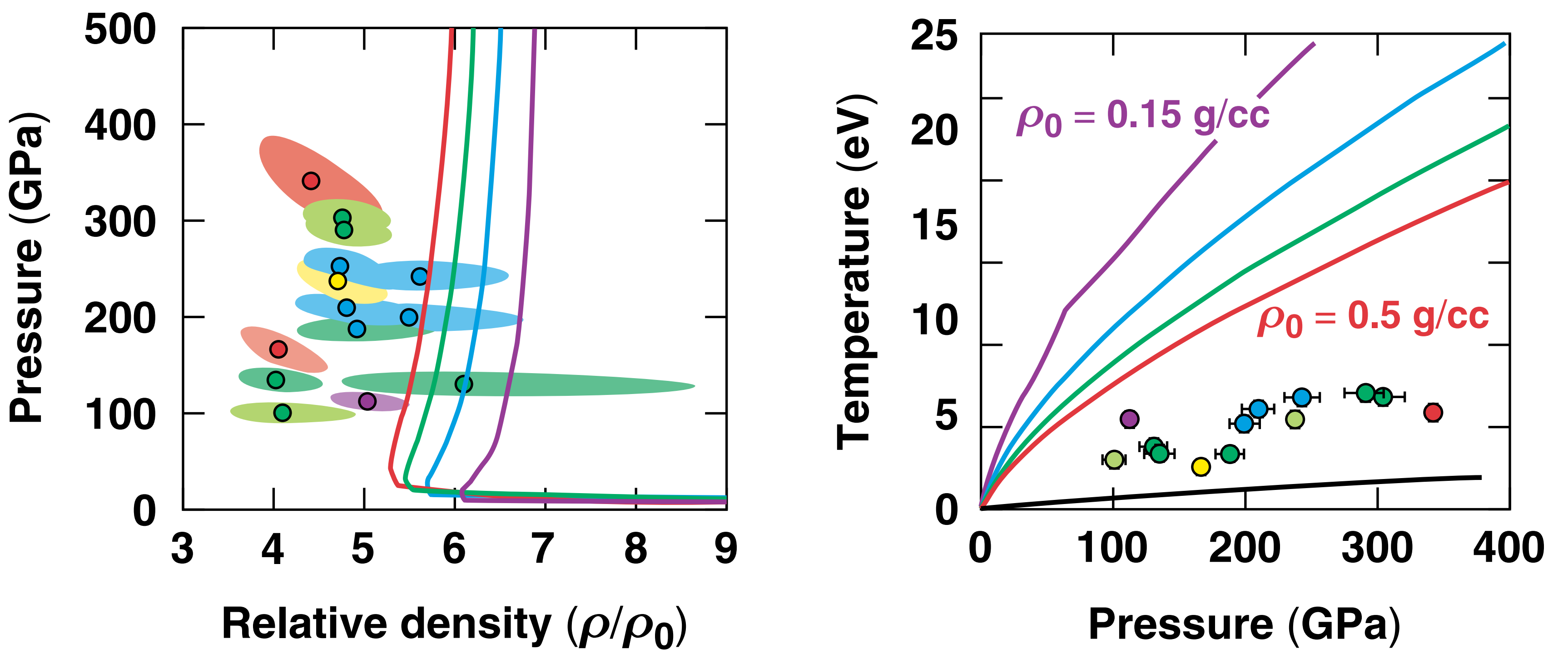

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Collaborators

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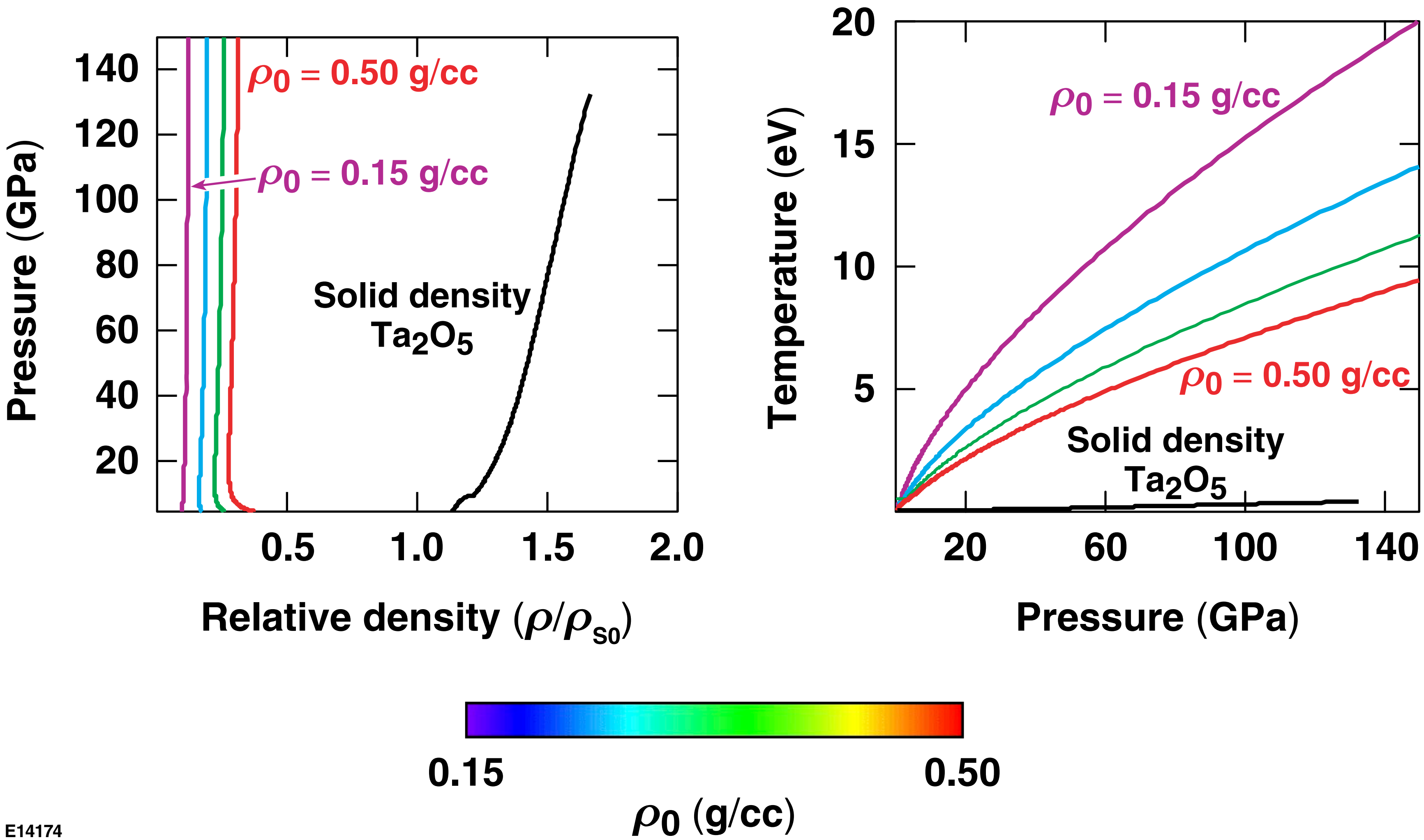
Equation of state measurements have been made of shocked, porous Ta_2O_5

- Ta_2O_5 foam EOS is of interest to HEDP and ICF experiments.
  - accesses off solid-state Hugoniot conditions
  - useful for radiation transport experiments
  - studied for hohlraum wall motion suppression
- Laser-driven impedance-match experiments were performed to obtain kinematic properties (U_s, U_p, ρ, and P). Simultaneous self-emission data from an optical pyrometer were used to infer the temperature of shocked states.
- Results indicate that a first version of the Ta_2O_5 QEOS* overpredicts both the compressibility and temperature of the material.

*QEOS courtesy of Dave Young, LLNL

Heating during the initial "crushing" of porous materials results in an anomalous EOS



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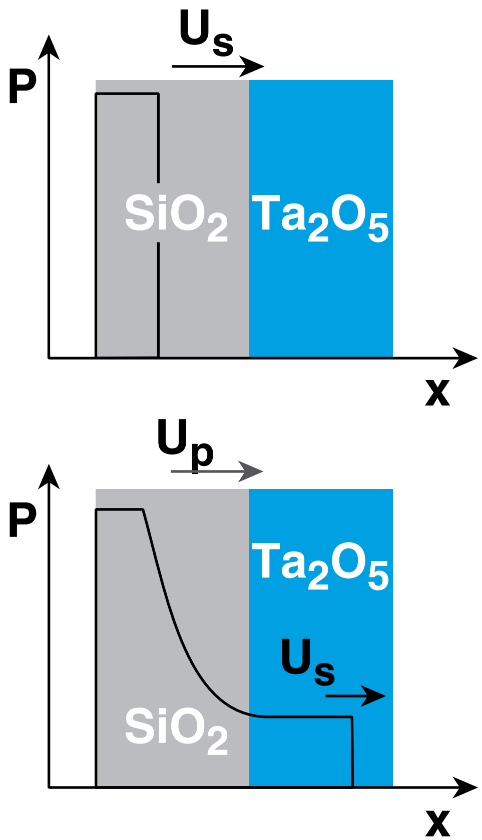
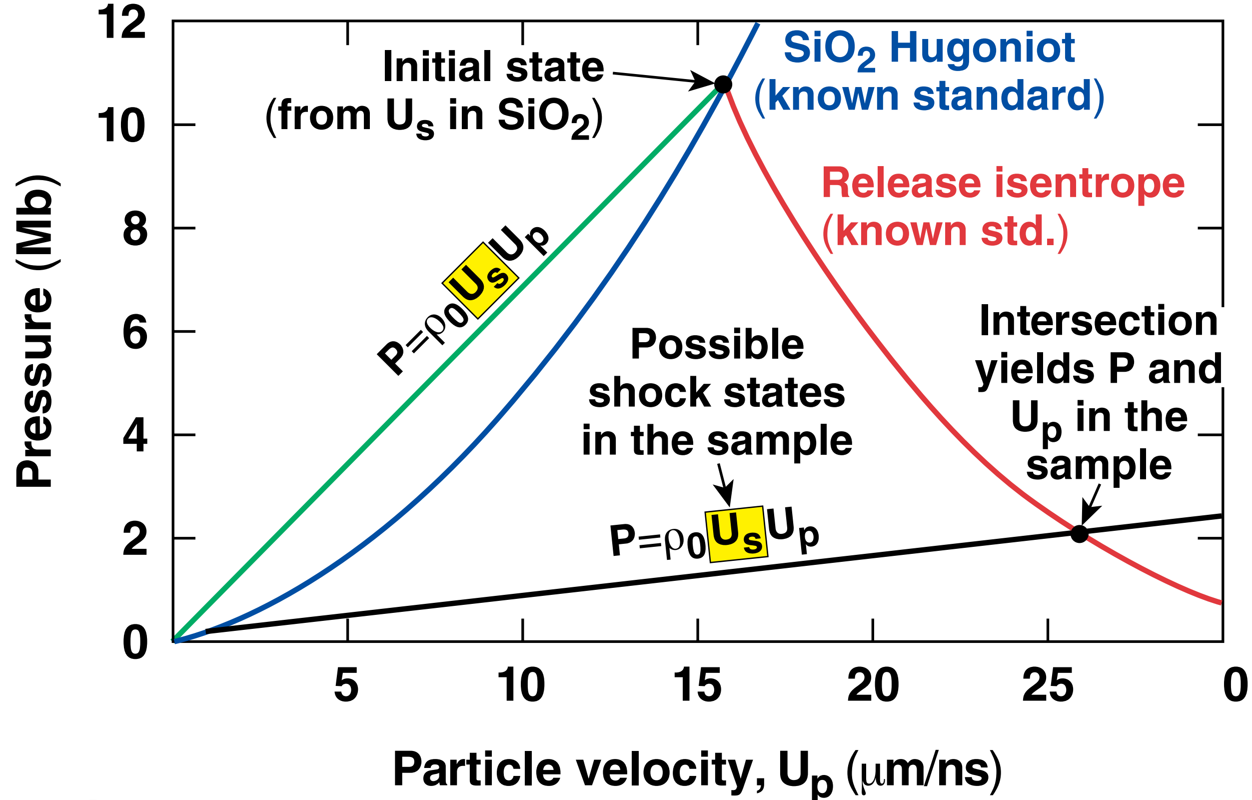
The impedance-match method relies on the shock and release behaviors of a known standard



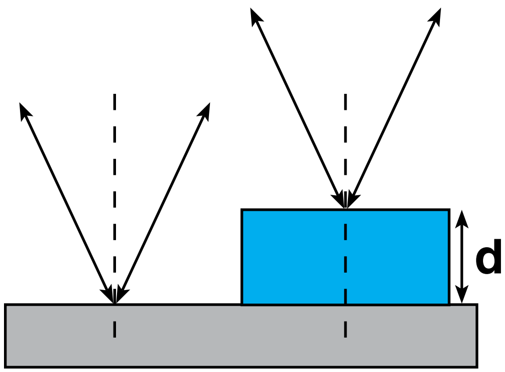


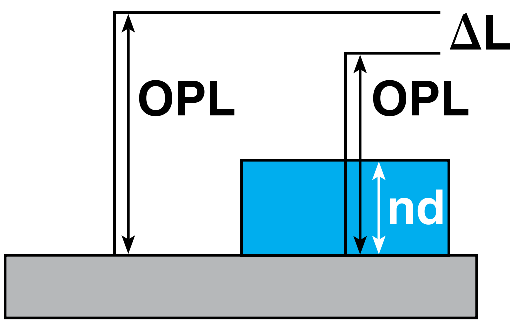
Rankine–Hugoniot equations:

$$\frac{\rho}{\rho_0} = \frac{U_s}{(U_s - U_p)} \qquad P - P_0 = \rho_0 U_s U_p$$

E12632a

We developed a technique to measure the foam's refractive index for the measurement of shock velocity

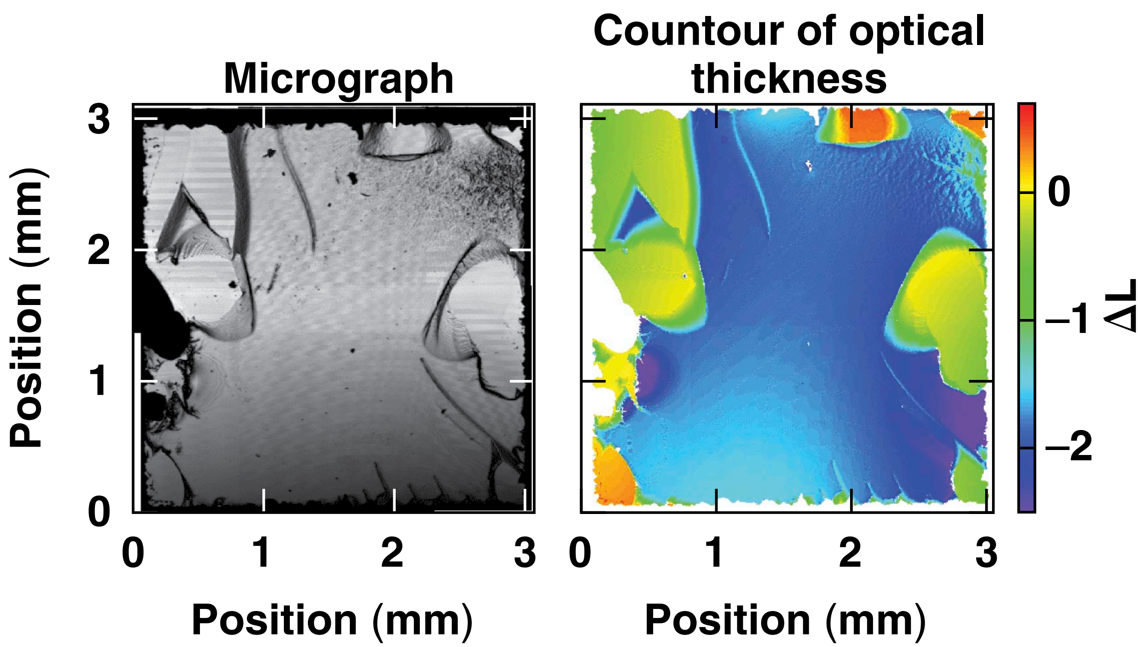




- We measure the sample thickness by microscopic depth of field.
- We measure the optical thickness by white-light interferometry (WYKO).
- Then $nd = \Delta L + d$.

$d \sim 100\ \mu m$ $\rho = 0.10$ g/cc $n \approx 1.016 \pm 0.001$

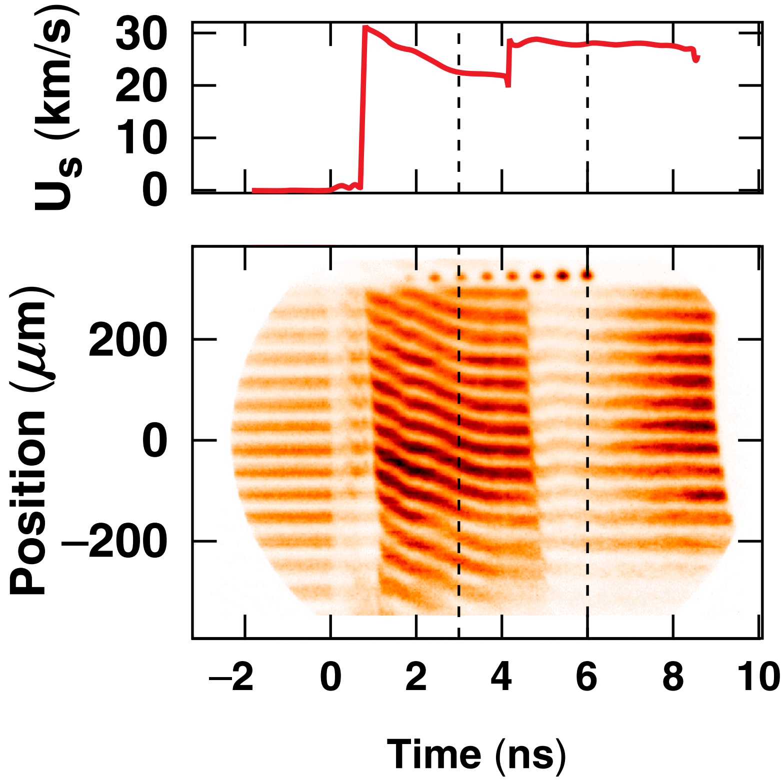
$\rho = 0.25$ g/cc $n \approx 1.023 \pm 0.001$



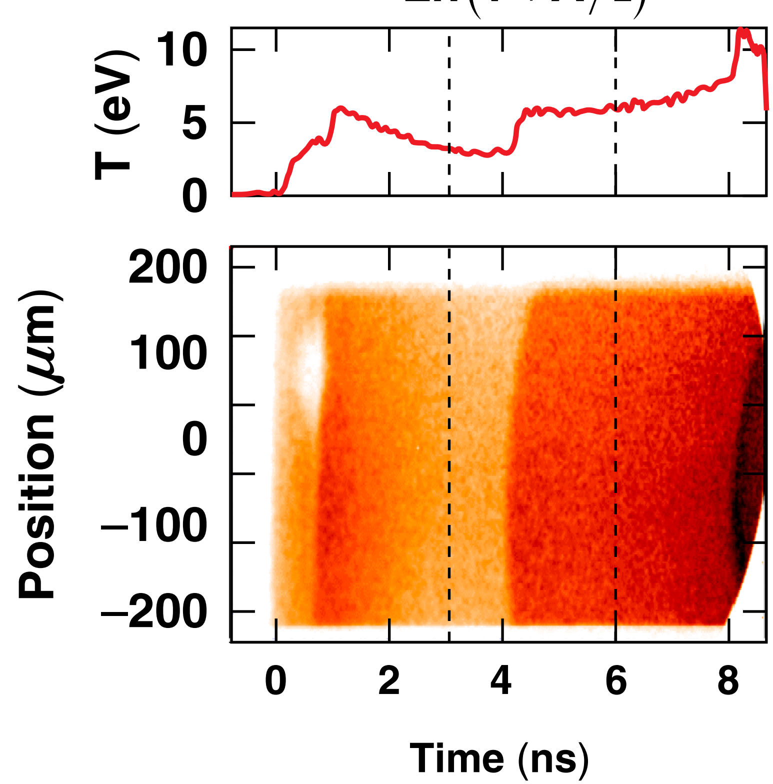
E14135

Simultaneous VISAR and SOP records of the optically transparent material give a continuous record of shock velocity and brightness temperature

$$U_s = f(n)\frac{d\phi}{dt}^{*}$$



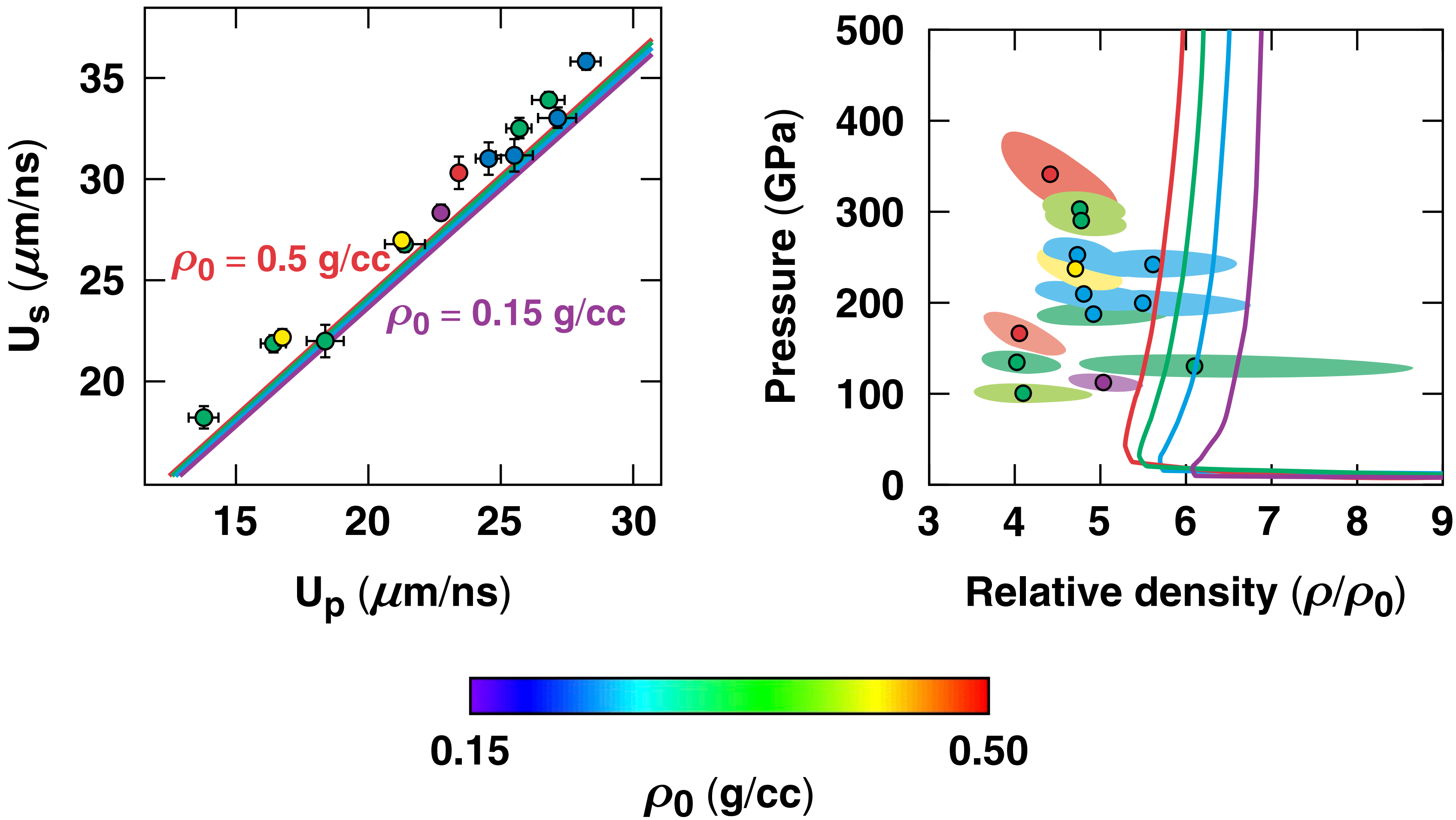
$$T = \frac{T_0}{\mathrm{Ln}(1 + A/I)}^{**}$$



*L. M. Barker and R. E. Hollenbach, J. Appl. Phys. 43, 4669 (1972).
**J. E. Miller *et al.*, presented at the 14th APS SCCM (2005).

E14136

Kinematic properties indicate a stiffer principle Hugoniot than the current QEOS model predicts



E14137

Temperature measurements on the SOP are a factor of 3 lower than the QEOS model predicts

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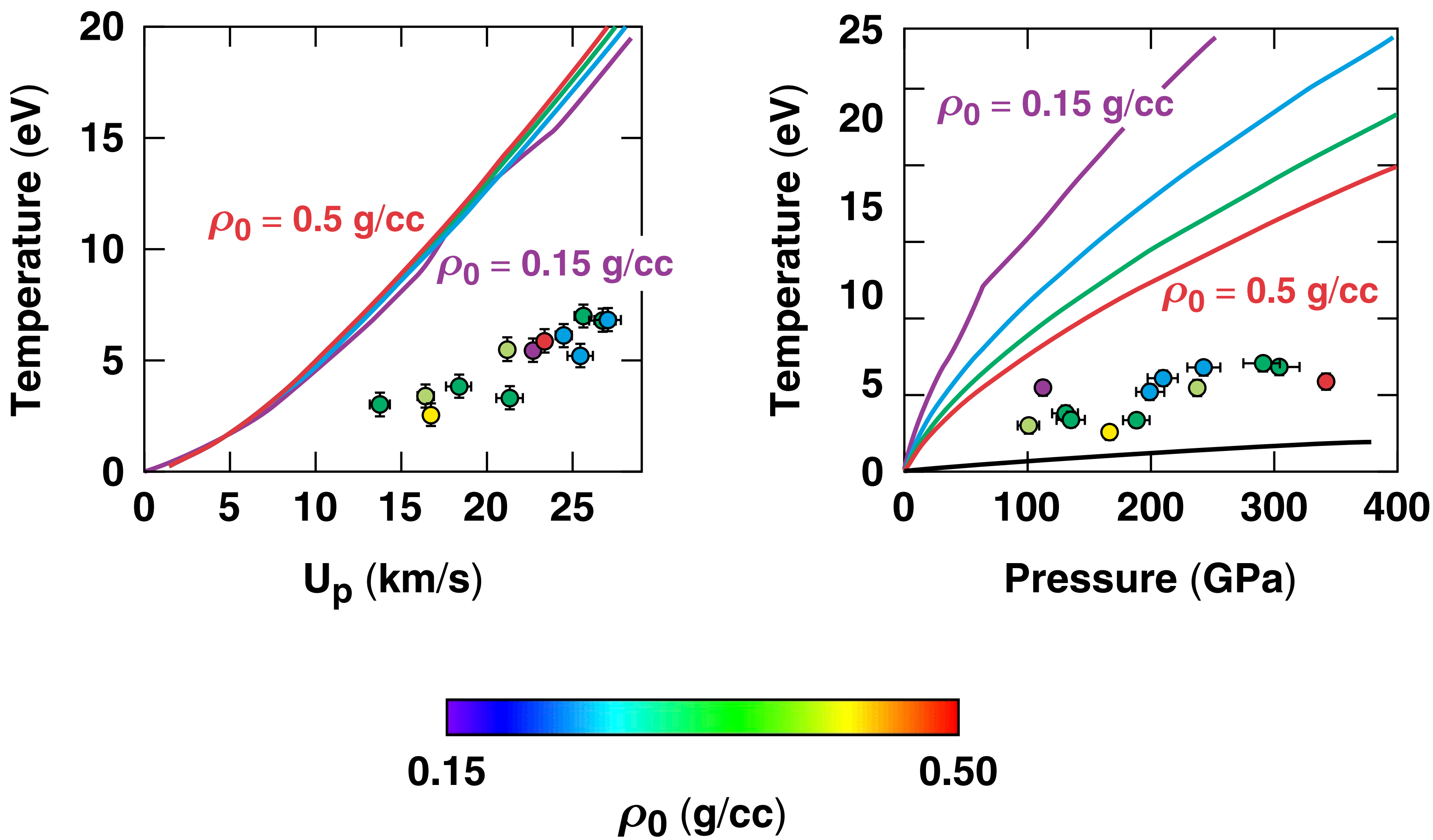

E14138

Equation of state measurements have been made of shocked, porous Ta_2O_5

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E14134

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