

Manufacturing and Characterization of Icy Simulants

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To aid in the development of sampling subsystems that can navigate the challenges of surface excavation, sample collection, and sample delivery in a variety of terrain conditions, we aim to reproducibly generate plausible solid icy simulants with a range of mechanical properties at a scale relevant to the activities of sampling tools testbeds.

Motivation: Uniform Icy Simulants

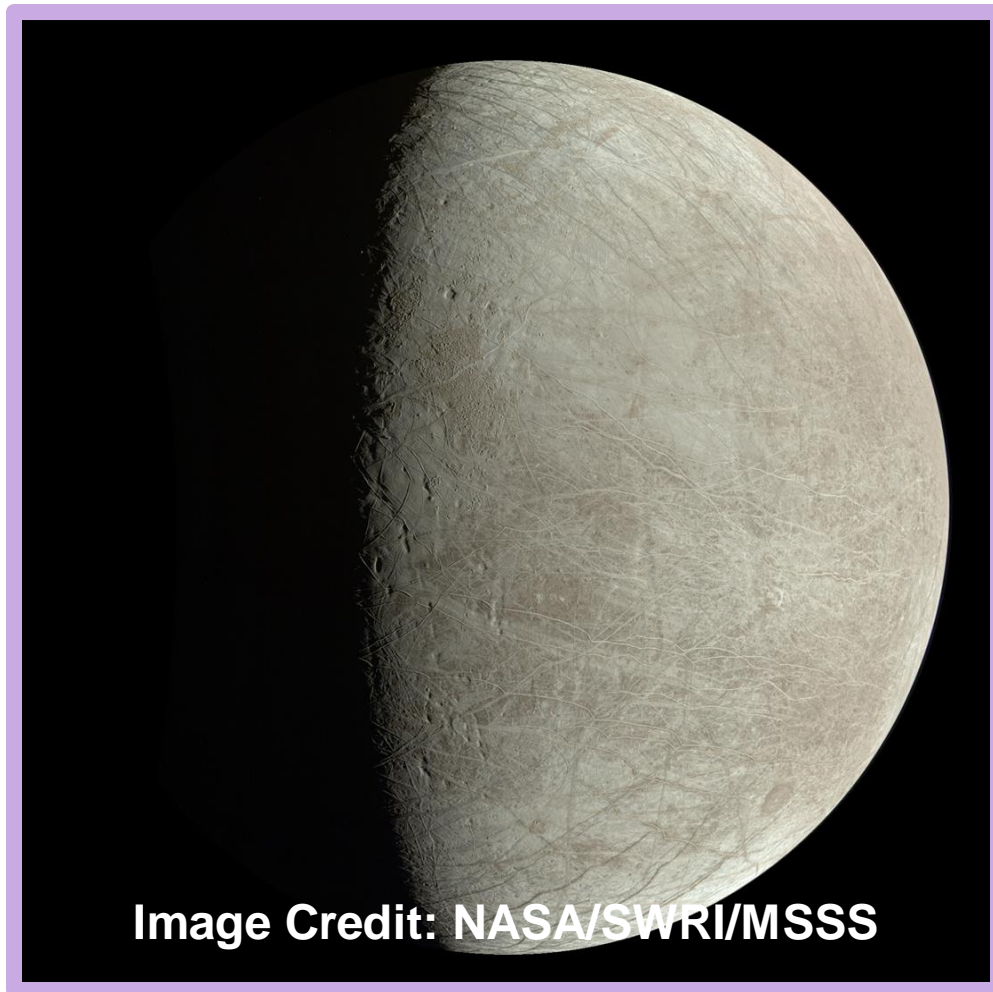


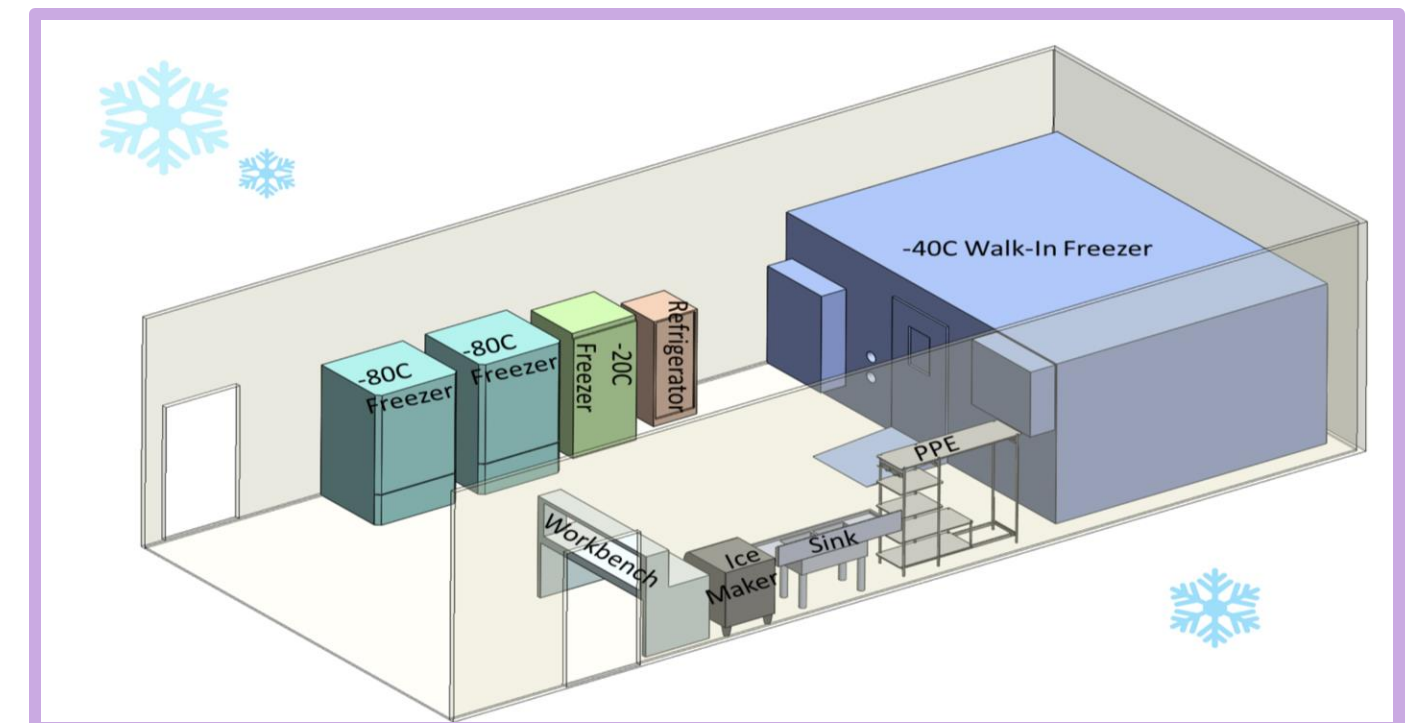
Image Credit: NASA/SWRI/MSSS

- NASA Jet Propulsion Laboratory (JPL) is conducting extensive development to advance technologies for surface exploration of Europa and other ocean worlds.
- Development includes landing on icy shell and collecting surface material for in-situ analysis.

- The main goal of the Simulants Team is to produce a suite of solid and granular ices with and without additives over a range of relevant mechanical properties in order to characterize the performance of sampling tools during development and test.

Capabilities for Icy Simulant Manufacturing

- We have developed a range of methods for producing, manufacturing, and delivering icy simulants
 - Bulk freezing (Home-made)
 - Commercial Ice
 - Granular ice manufacturing
 - Specialty simulants (e.g., "scary")
- We manage a suite of instruments and specialized laboratories dedicated to ice manufacturing
- Testing/characterization methods:
 - Porosity
 - Concentration uniformity
 - Flexural strength (impact tower)
 - Uniaxial compressive strength (UCS)
 - Shore A/D hardness
 - Raman for additive phases
 - Cryo-microscopy

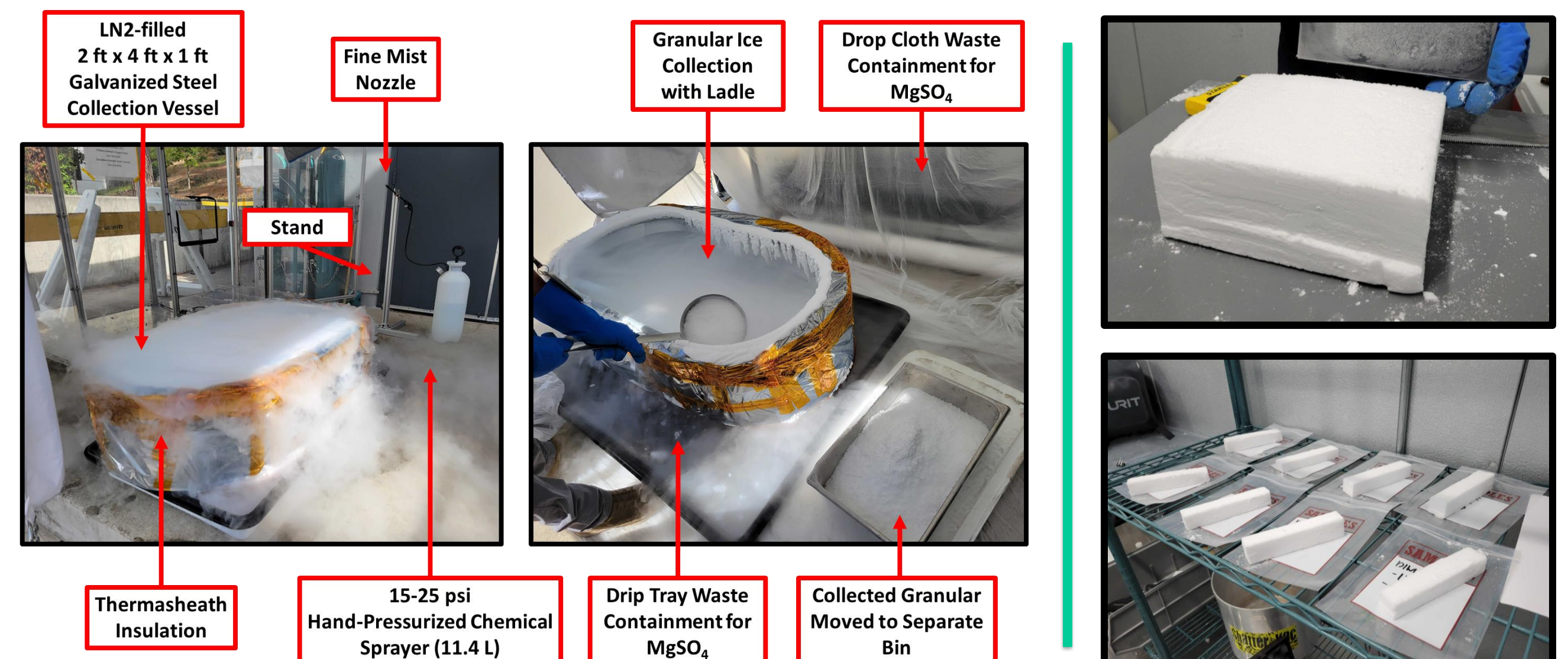


Icy Simulants



Before Impact

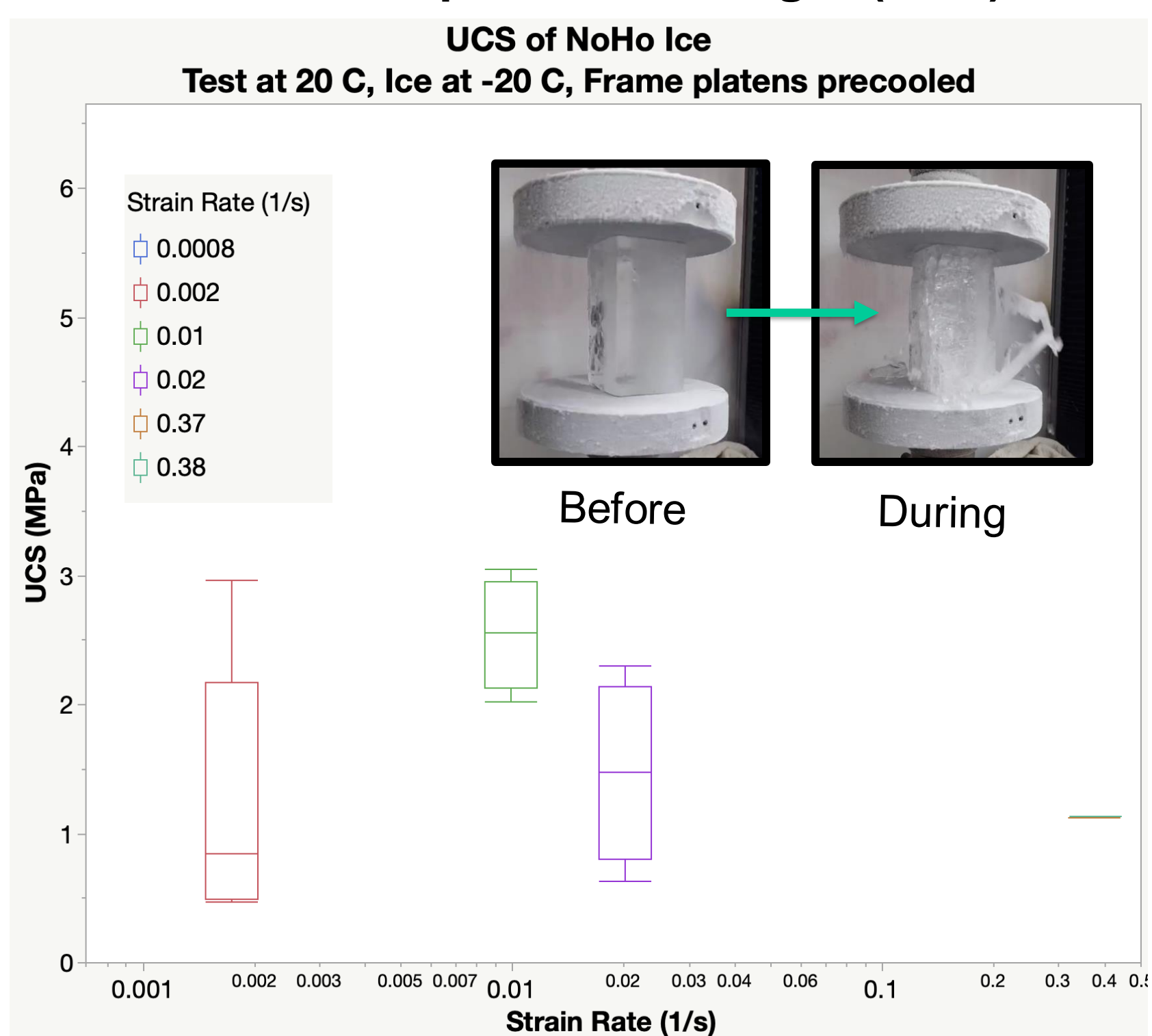
Granular Ice Manufacturing



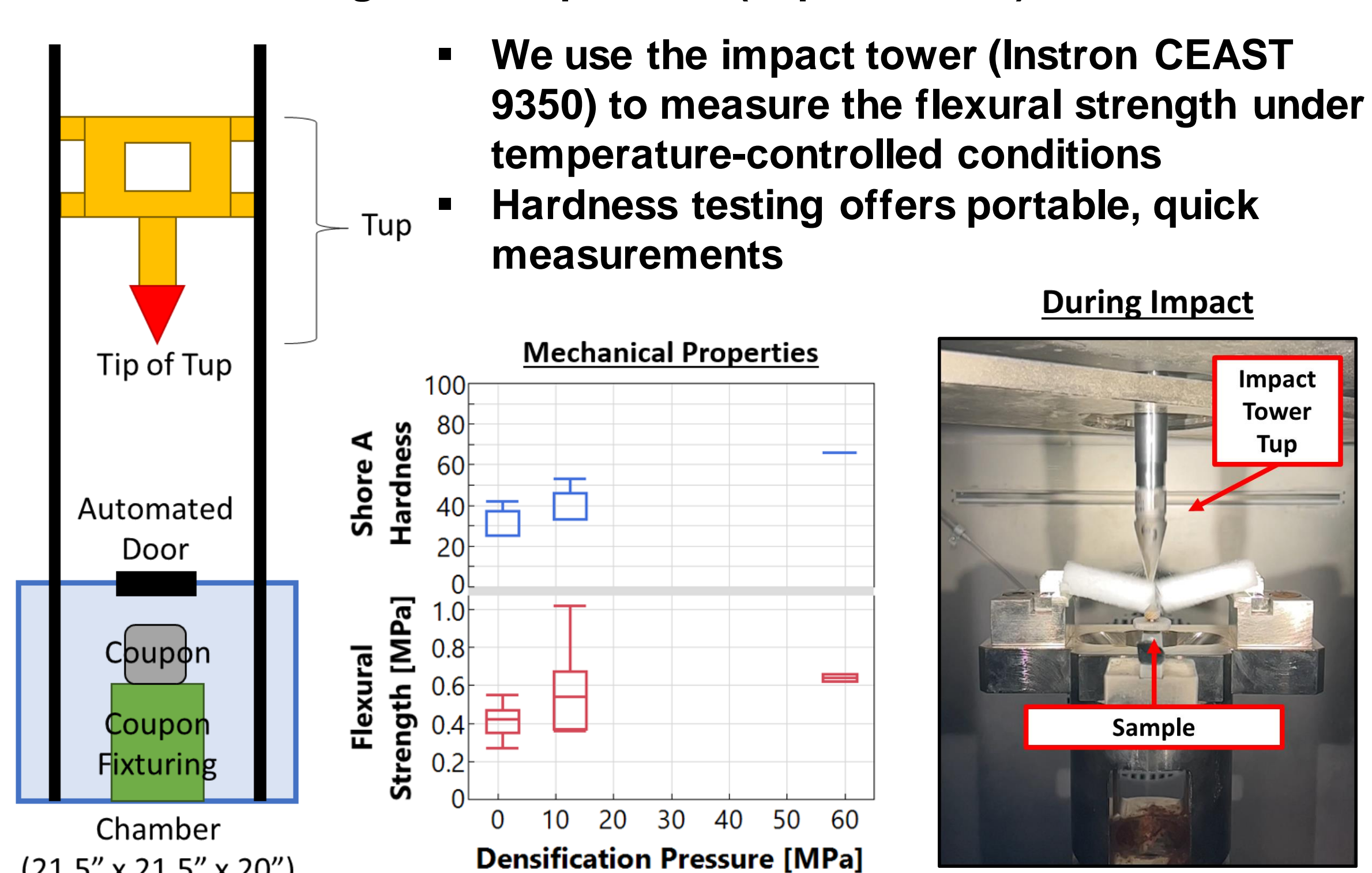
- Flash freezing prevents processes that result in macro-scale phase separation, enabling uniform test articles with additives ($MgSO_4$)
- Large grain diameters (169 - 317 μm) and small (10 μm) are available

Characterization Methods and Examples

Uniaxial Compressive Strength (UCS)

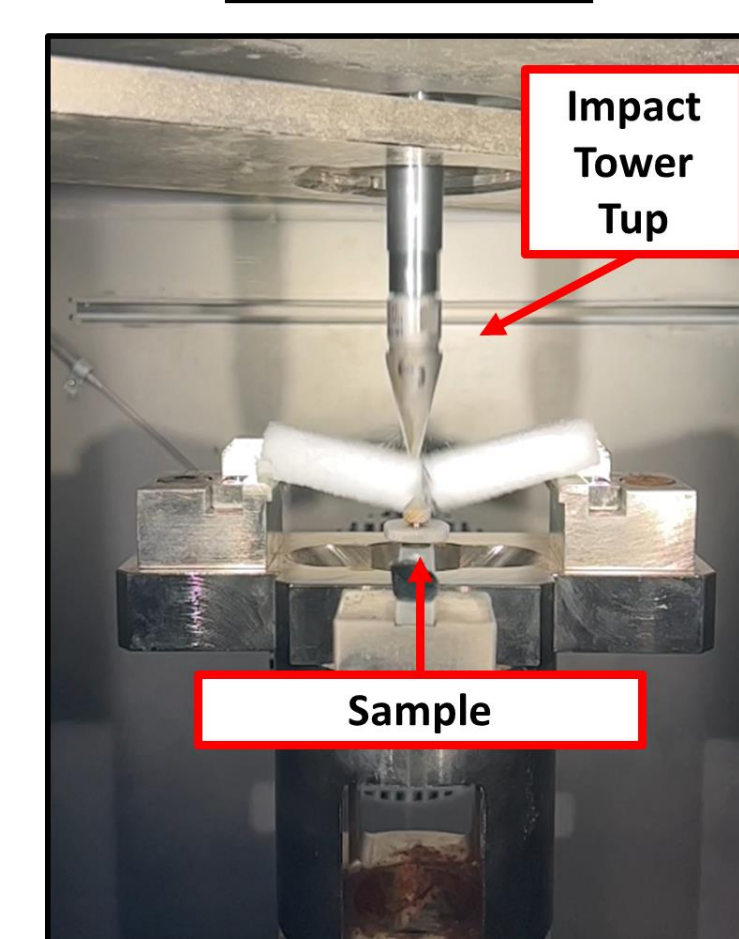


Flexural Strength at Temperature (Impact Tower) and Hardness



- We use the impact tower (Instron CEAST 9350) to measure the flexural strength under temperature-controlled conditions
- Hardness testing offers portable, quick measurements

During Impact



Future Work

- Continue to push the range of properties we generate
- Testing with sampling tools to understand the ways in which simulant mechanical properties pose sample excavation, collection, and delivery challenges.

Thank You

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