

Idaho National Laboratory (INL) is building a sodium-cooled test reactor to help make advances to nuclear power.



Fuel pin jackets will be 6ft long with 0.25in diameter and hold 5g of sodium.

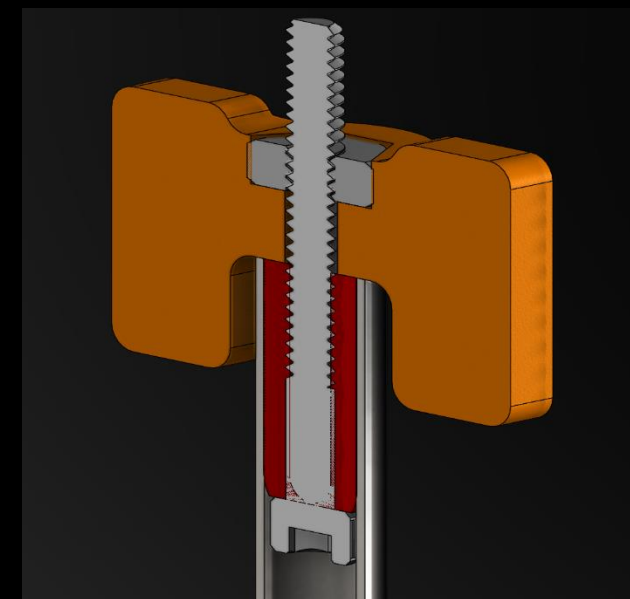


SODIUM LOADING AND TESTING PROCESS

1. In the glove box, sodium wires are extruded, cut from the press, and straightened before being placed into the pins.
2. The pins are capped, then removed from the glove box to be heated to 150 °C for 30min to consolidate the sodium.
3. Ultrasonic testing is performed, and the pins are returned to the glove box for cutting and removed for imaging.

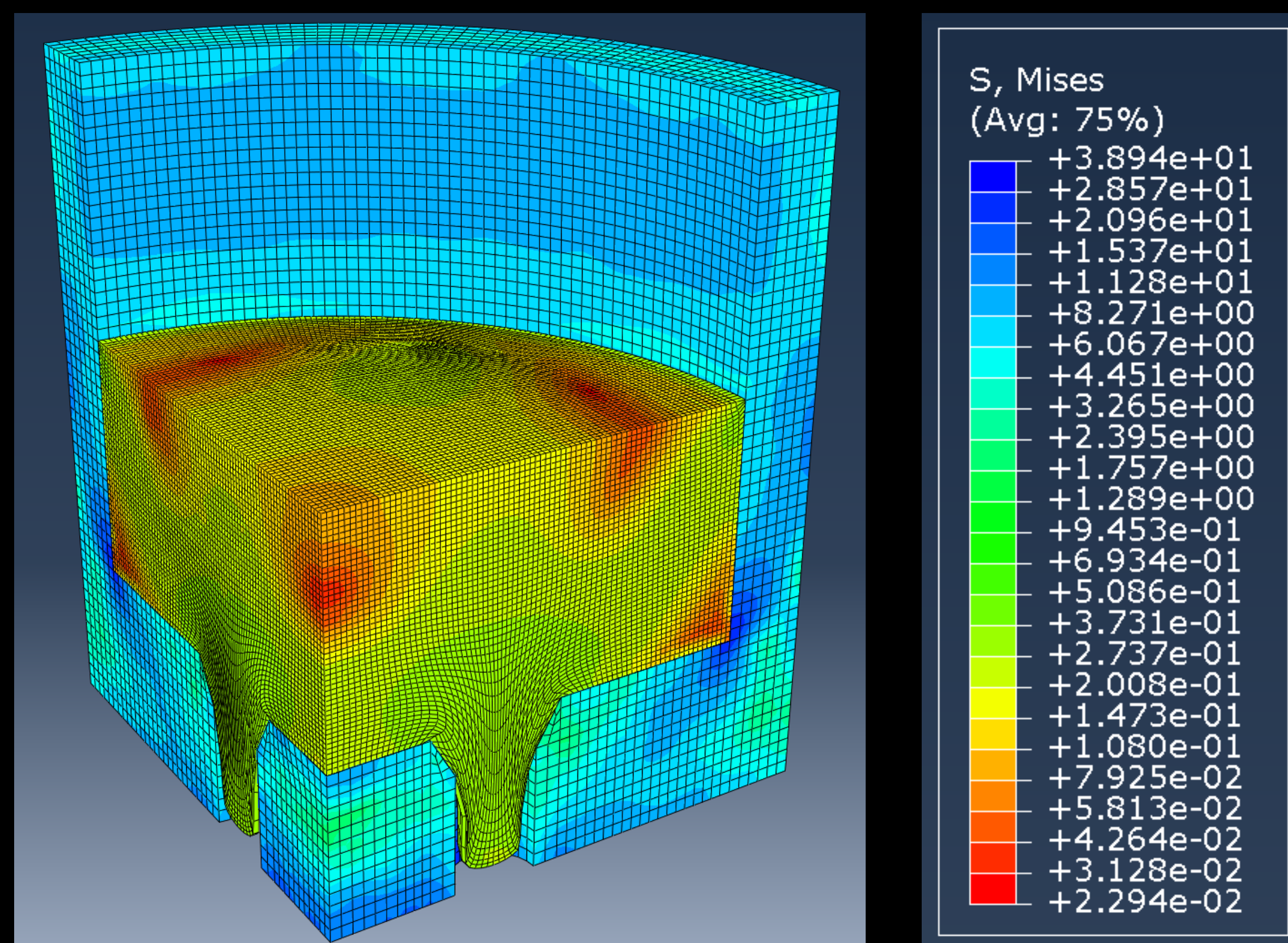
EXPANSION PLUGS

The fuel pins must be capped with airtight, removeable end caps to prevent oxygen from reacting with the sodium.



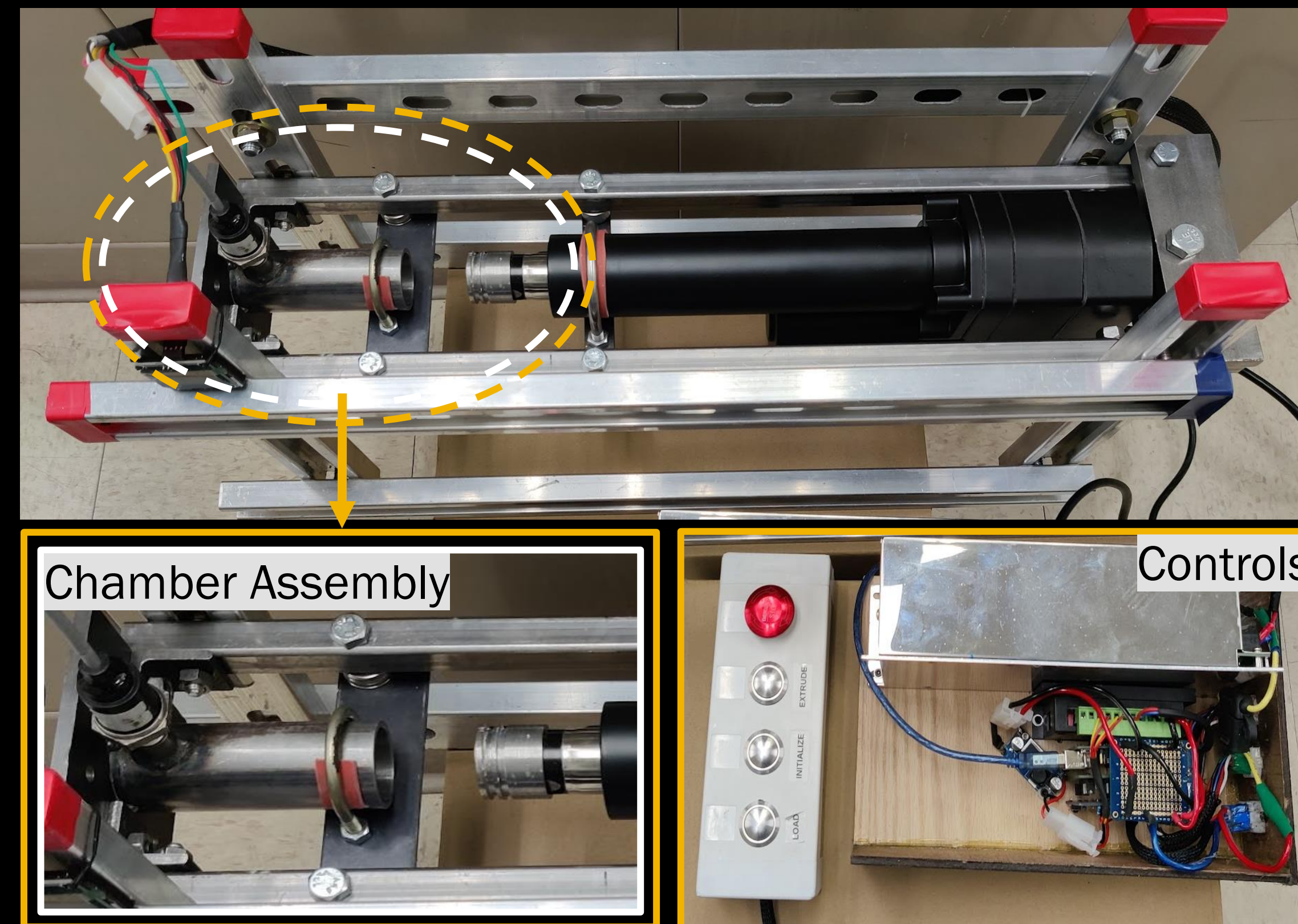
FINITE ELEMENT ANALYSIS

Finite Element Analysis (FEA) was performed on the extrusion chamber and die plate to help validate reaction forces, stresses, and strains placed on the die holes by the sodium.



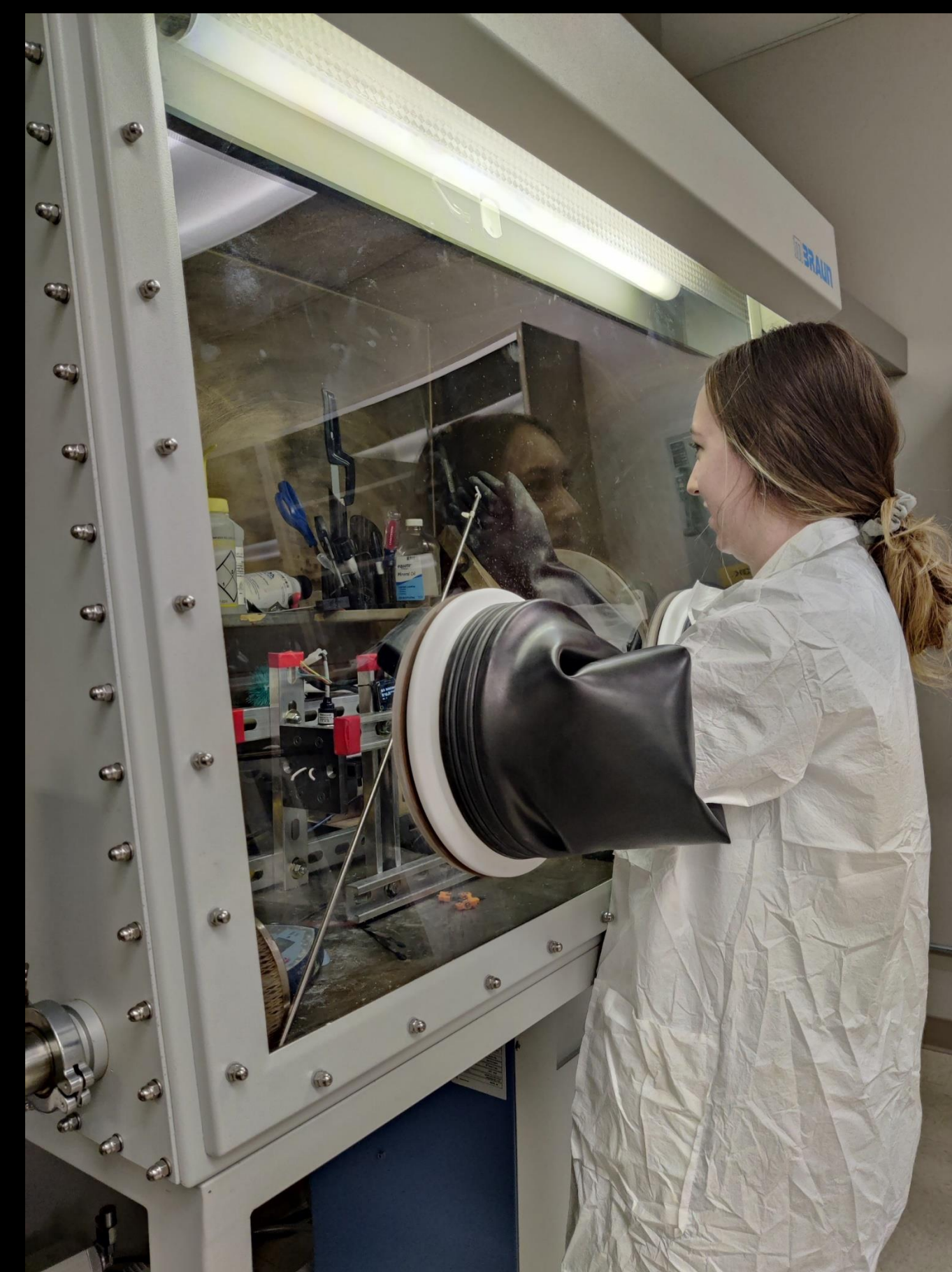
FEA of 1/4 extrusion chamber showing von Mises stress (MPa)

EXTRUSION PRESS



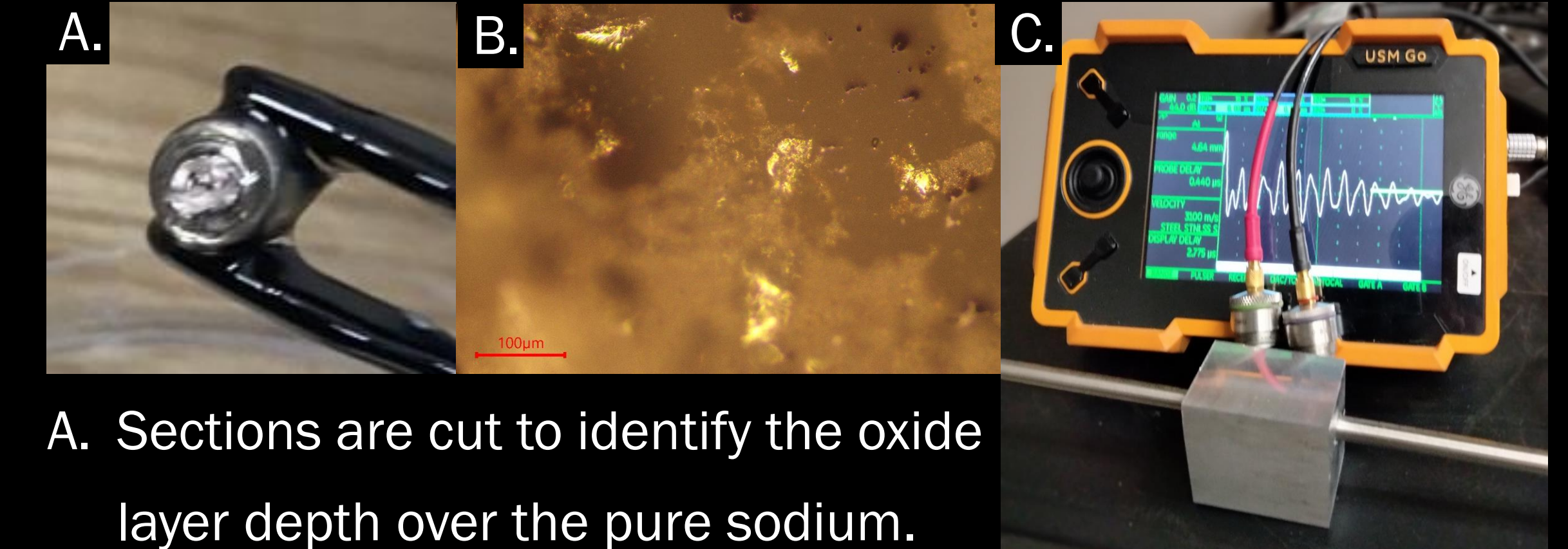
A 12V, Arduino controlled system powers a linear actuator that presses a ram into an extrusion chamber to force sodium out of 8 -1/8" die holes at the front of the assembly.

GLOVE BOX



As sodium reacts with oxygen and water, all work is performed in an inert argon atmosphere glove box to prevent adverse reactions.

SODIUM ANALYSIS



- A. Sections are cut to identify the oxide layer depth over the pure sodium.
- B. Optical microscopy is used to see areas of sodium in the pins and the difference in oxidized and unoxidized sodium.
- C. Ultrasonic testing is used to validate the heating process by identifying the top of the sodium without being destructive.

SCALABILITY

INL wants to create at least 300 fuel pins jackets per 40-hour work week. Currently, it takes about 5-7 minutes to extrude, load, and cap each fuel pin, or 25-35 hours per week. Scale could be increased by producing more sodium wires at once and by extruding wires and filling pins at the same time.

CONCLUSION

The oxidation in the pins is directly related to the amount of oxygen present in the glove box. Typically, the oxide layer is less than 0.125" in depth and can be scrapped off.

ACKNOWLEDGEMENTS

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