

Engineering Portfolio: Design, Development & Innovation

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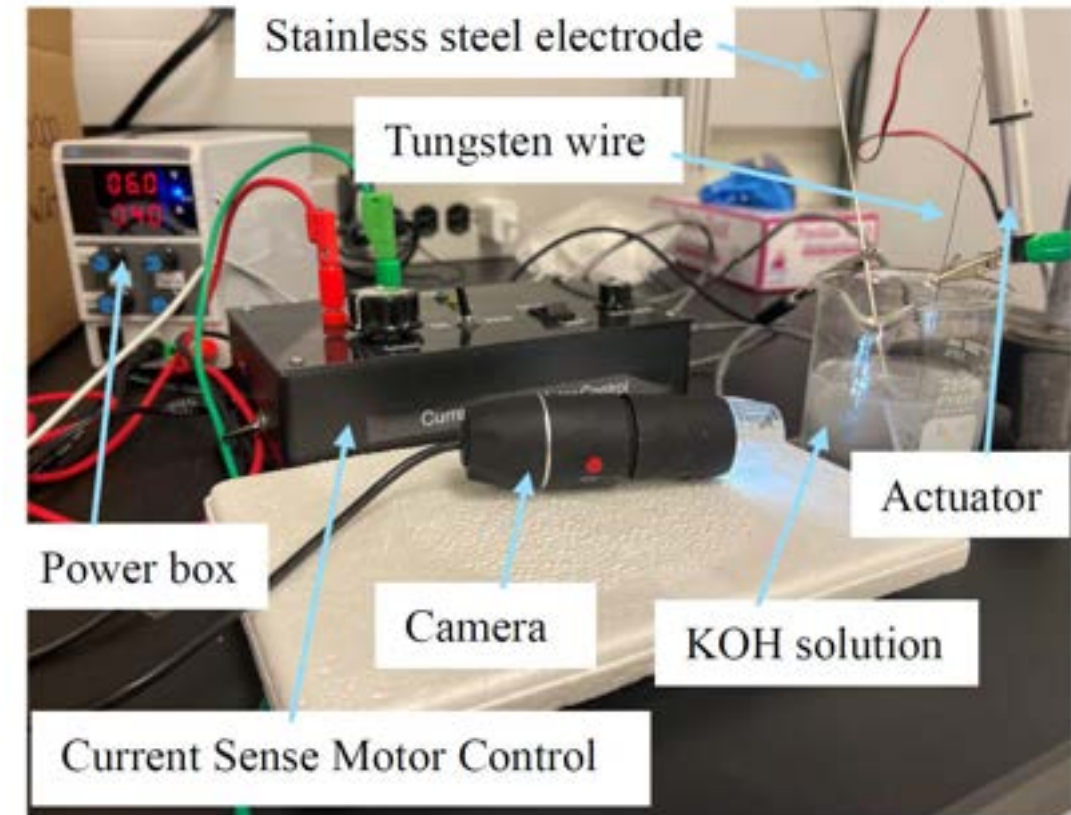
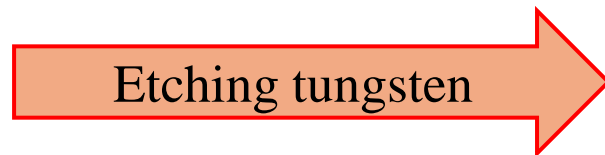
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Ultra-Sharp Tungsten Needle Production: Improved results and increased productivity

Objective: Develop a reliable method for producing sharp tungsten needles with a smooth conical tip.

Initial Approach:

- Used static electrochemical etching with a drop-off technique.
- Tungsten wire dissolved at the meniscus until detachment caused a current disturbance.
- A detection system sensed the disturbance and retracted the needle.



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Challenges:

- Etched needles had multiple steps on the surface.
- Tips were often off-center or broken.
- Low success rate: Only 1–2 out of 50 needles had an acceptable shape and geometry.

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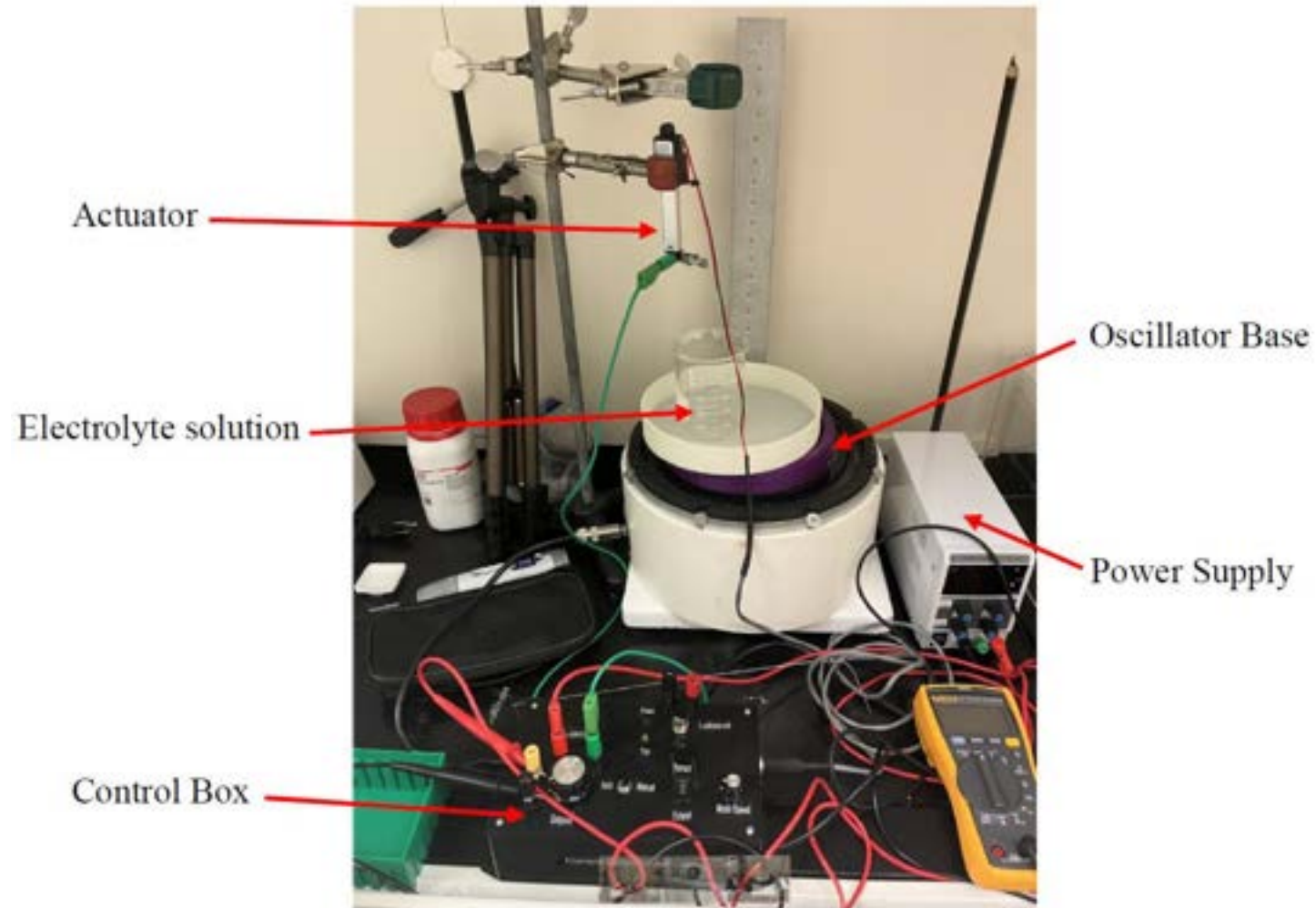
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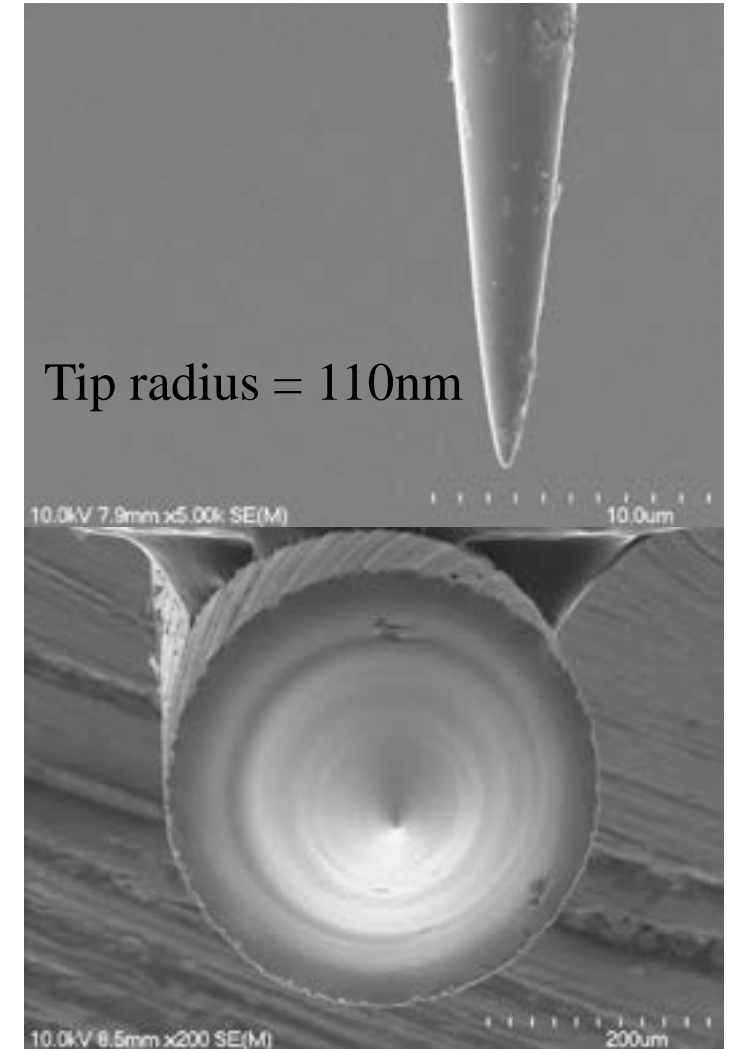
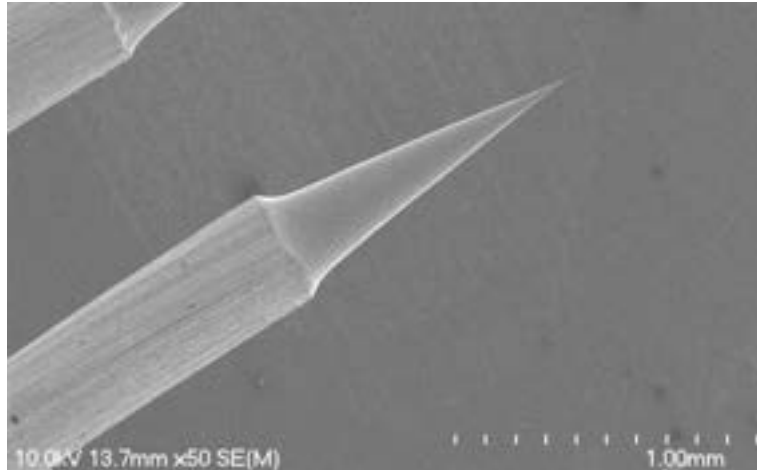
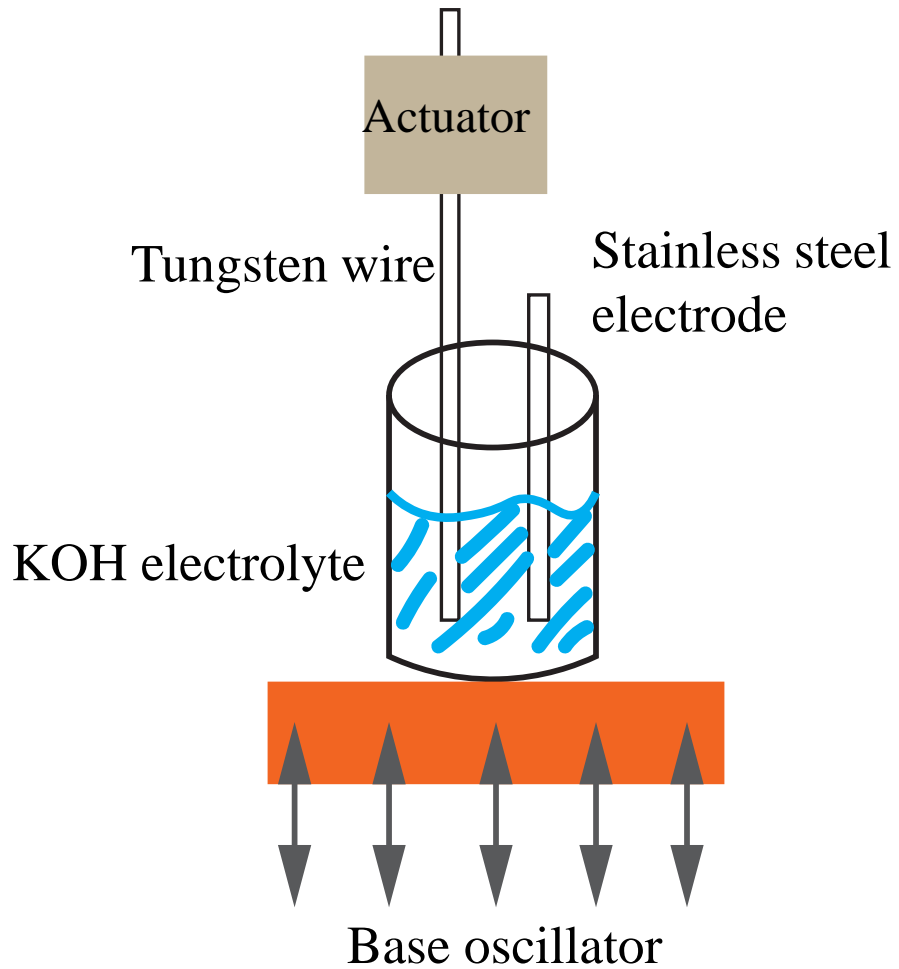
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Solution:

- A review of electrochemical etching studies revealed similar issues.
- Research showed that step formation resulted from the meniscus lowering as tungsten dissolved.
- Since maintaining a fixed meniscus level was impractical, studies suggested using a **dynamic etching setup** to keep its range constant.



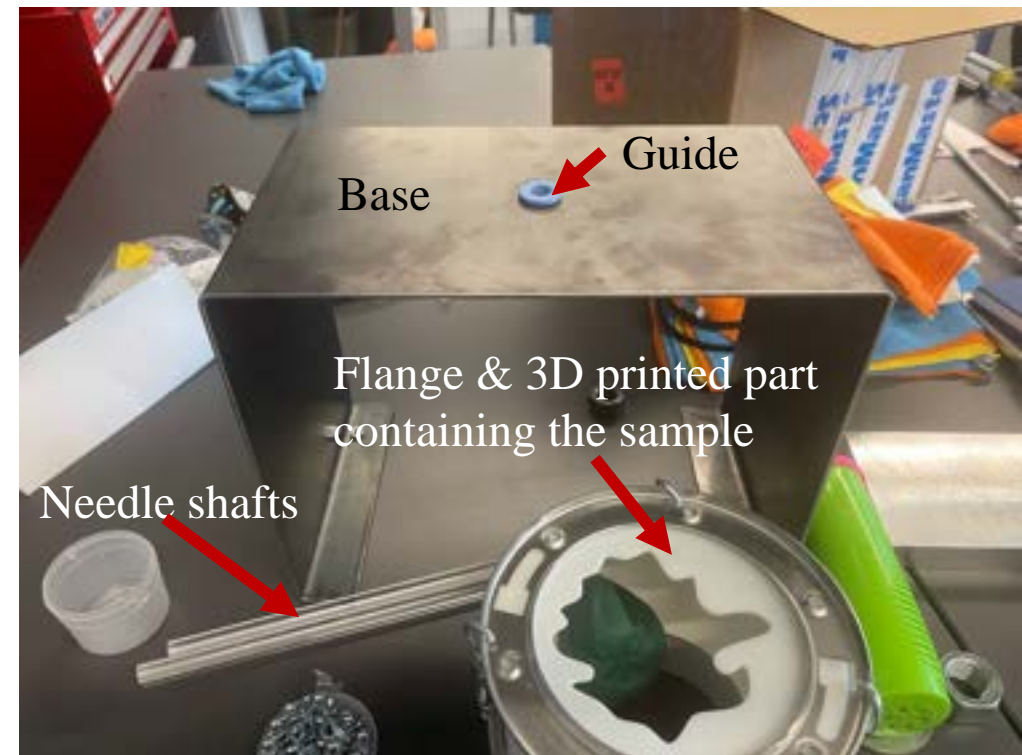
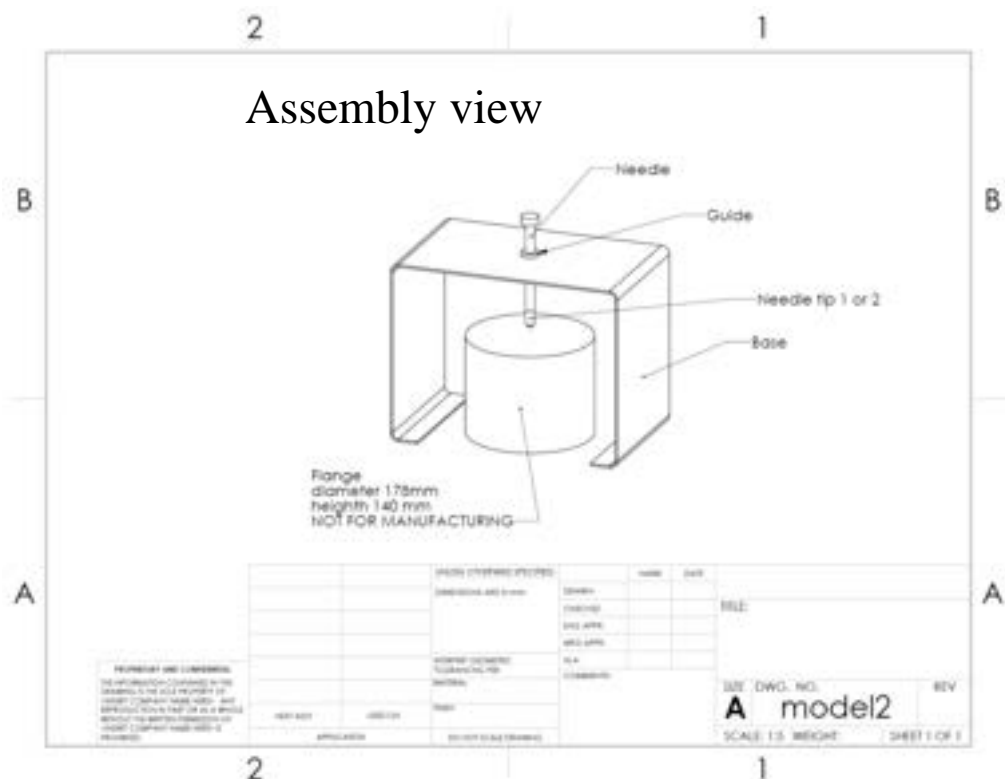
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Simplified Nanoindentation Machine Development for Training Purposes

Objective:

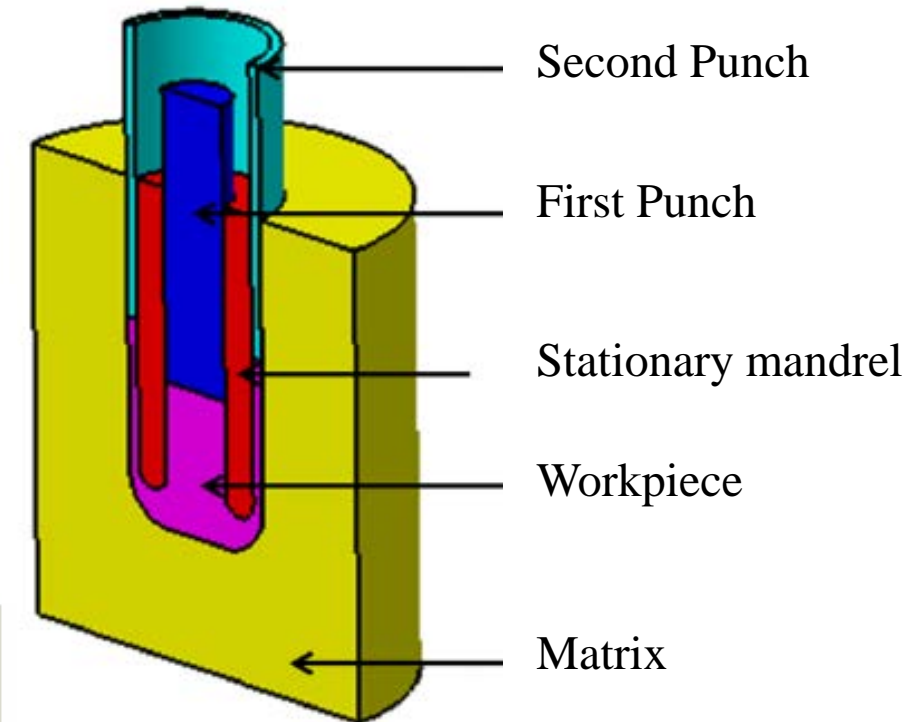
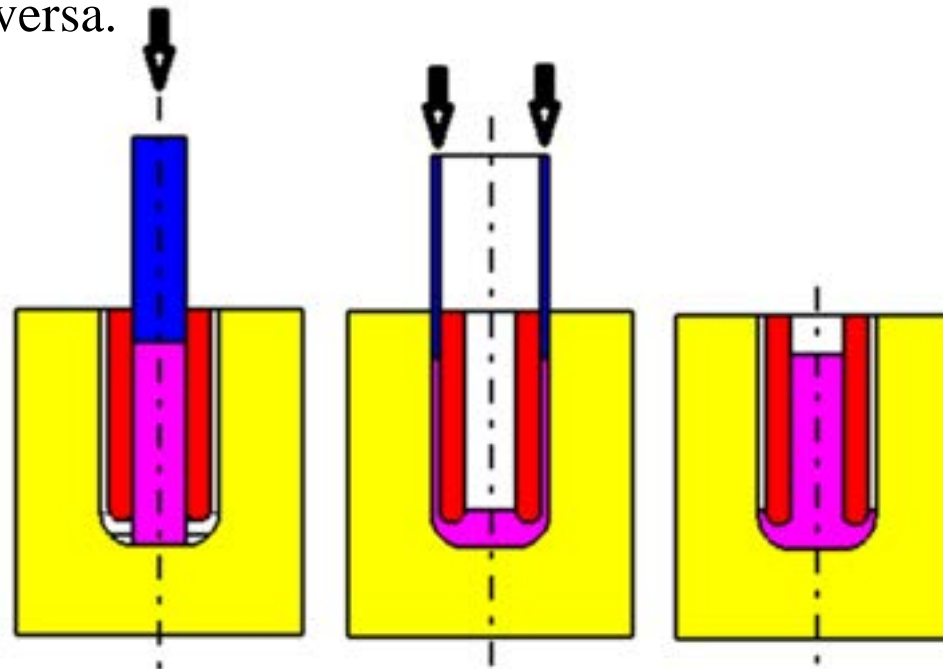
- Develop a scaled-up (x1,000) prototype to demonstrate nanoindentation in a tangible form.
- Minimize manufacturing requirements by utilizing off-the-shelf components, such as the needle shaft and the flange serving as the "guide".



Radial Backward Extrusion Setup From Concept to Manufacturing

Objective:

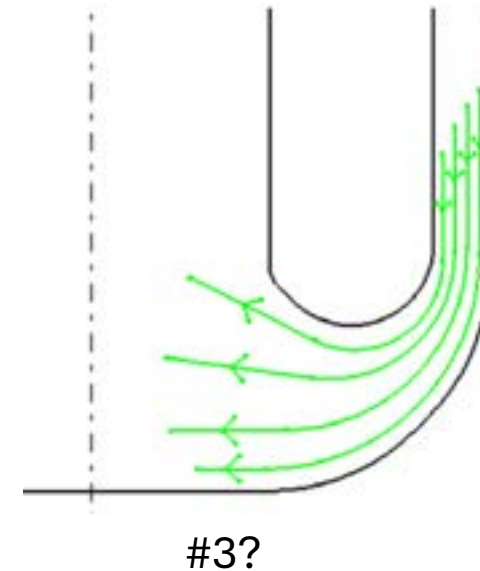
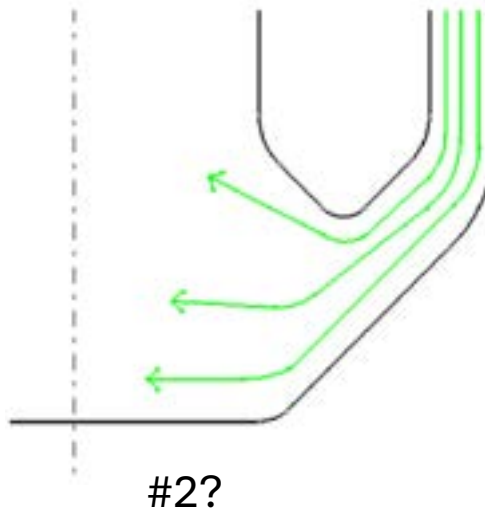
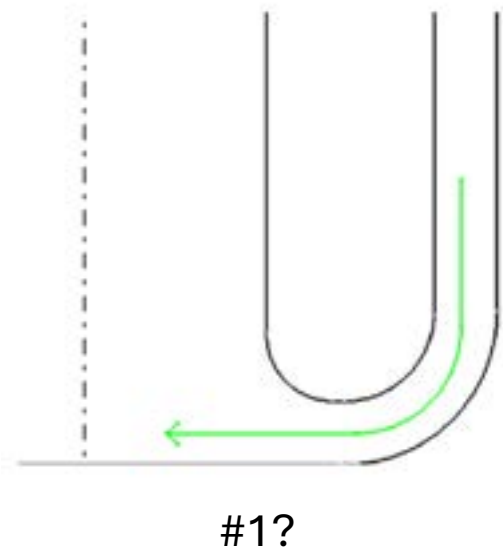
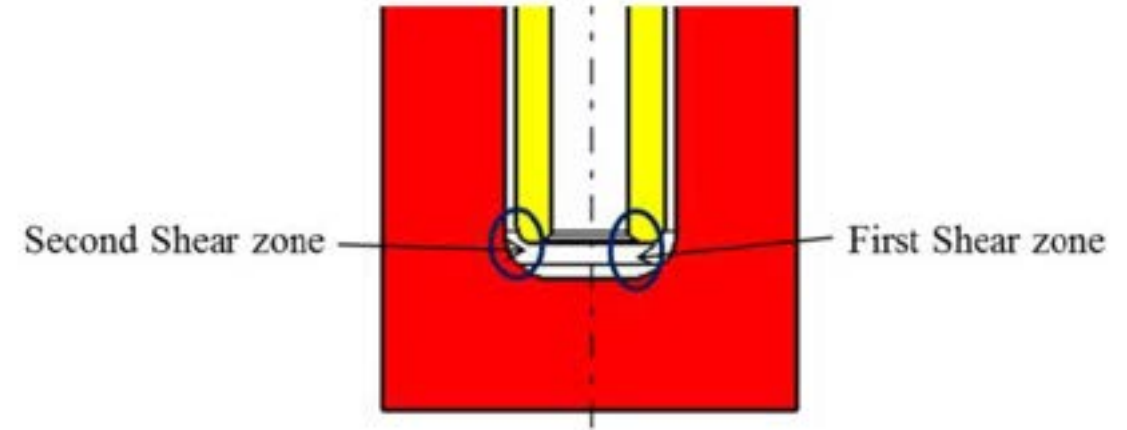
- Introduce a severe plastic deformation (SPD) method to produce ultra-fine gran rods, and tubes.
- The matrix includes a stationary mandrel at the center, which forms the forming channels.
- Two punches act sequentially to transform the workpiece from a rod to a tube and vice versa.



Radial Backward Extrusion Setup From Concept to Manufacturing

Challenges:

- Converting a tube to a rod required a carefully designed system to prevent the formation of hollow rods.
- Designing the shear zones to guide the material flow, ensuring the rod fills its center naturally without the need for external back pressure.



Radial Backward Extrusion Setup From Concept to Manufacturing

Assembly



Matrix



Stationary mandrel



Solution:

- Simulations confirmed that the third design successfully addressed all challenges.
- The setup was designed, manufactured, and tested using this design.