Ultrasonic Deep Drawing With Ironing

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Background

Application of high power ultrasonic (US) vibrations can significantly improve metal forming processes through increased plastic deformation and reduction of surface friction.
Background

Karl Graff’s research in US forming, additive manufacturing, and machining (conducted at EWI and OSU) produced special capabilities in high power ultrasonic systems to address issues of forming advanced materials.
Research Goal

- To demonstrate the capability of a high power ultrasonic deep drawing/ironing process to form Al 5XXX and SS314/316 alloys
- To determine best options for applying US vibrations

Diagram:
- Axial vibrations of punch
- Radial vibrations of blank holder
- Radial vibrations of die
Radial Die Vibrations

- **Approach to applying US vibrations**
  
  One or more US transducers place die into radial vibrations

- **This approach can be applied to either the die or the blank holder**

Note: It is planned to draw a 6” OD cup
Ironing Draw

- For research phase, US ironing to be carried out as a second step following deep draw, see below
- Will permit separate evaluation of deep draw and ironing steps

Example drawn and ironed cup sample
Evaluation Criteria

Data and evaluation will include:

- Draw force – to be measured with/without US vibrations for drawing and ironing tests
- US amplitude and power – to be measured
- Surface inspection – for wrinkling, galling, and cracking
- Limiting draw ratios – testing materials with/without US
- Process modeling – to assess the friction reduction effects of US deep drawing
Approach

- Task 1 – State of the art review on US forming applications
- Task 2 – Simulation based-design and fabrication of the US deep draw dies
- Task 3 – Conduct deep draw tests and analysis
- Task 4 – Conduct US ironing study and analysis

160-Ton Hydraulic Press – to be used in study
Deliverables & Performance Period

- **Deliverables:**
  - Reporting (monthly basis, at the end of each task and a final)
  - Material properties, Tooling design
  - Process modeling results
  - Experimental data of hot / warm forming and welding
  - Destructive test results

- **Performance period: 12 months**

- **The final project scope including budget and materials will be determined with the inputs of industry partners.**

If you want to know more about the detailed project plan of the project topic, please free to contact Hyunok Kim (hkim@ewi.org / 614.688.5239).
Questions & Contact

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