A Precision Wire Drawing System: Development and Results

UIA Symposium: Industrial Session

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Outline

- **Project Objectives**
- **Prior Work**
- **Stack Design & Construction**
- **Wire Drawing Experiments**
- **Experimental Results**
  - Reduced draw forces
  - Cleaning
  - Improved smoothness
- **Summary**

Project Objectives

- **The objectives of this project were to:**
  - Design and build a special purpose ultrasonic wire drawing unit
  - Carry out ultrasonic wire drawing tests on a high alloy wire
- **The intent was to improve the surface finish of the wire.**
  - Wire was Carpenter MP35N (Ni-Co-Cr-Mo)
    - Not primarily an electrical wire
  - Nominal diameter ~0.005”
- **Literature review was Step 1.**

Testing apparatus from prior work

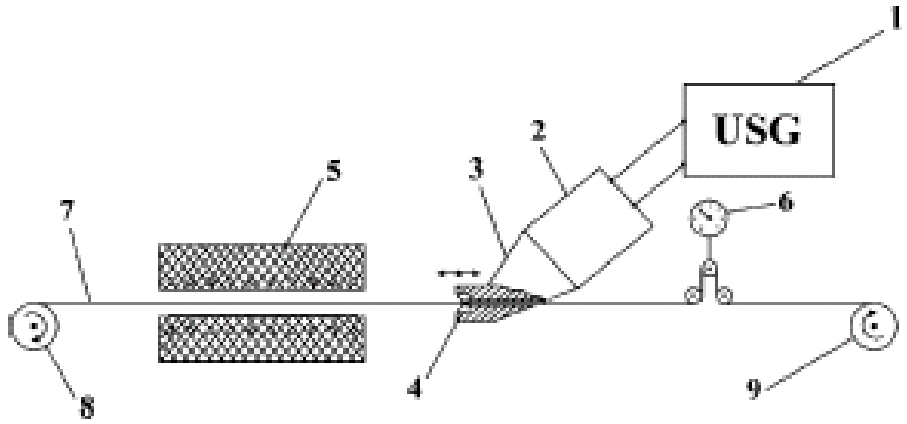


Fig. 1. A scheme of apparatus for wire drawing with superimposed ultrasonic vibrations: (1) ultrasonic generator, (2) ultrasonic transducer, (3) ultrasonic horn, (4) die, (5) pusher-type furnace, (6) dynamometer, (7) wire, (8, 9) spools.

Mordyuke, B.N., Mordyuk, V.S. and Buryak, V.V., "Ultrasonic drawing of tungsten wire for incandescent lamps production," *Ultrasonics*, Vol. 32 (2004) pp. 109–111.

Prior work – surface finish

- **From past work…**

Photo on left shows wire drawn without ultrasonic energy; photo on right show with drawn with ultrasonic energy.

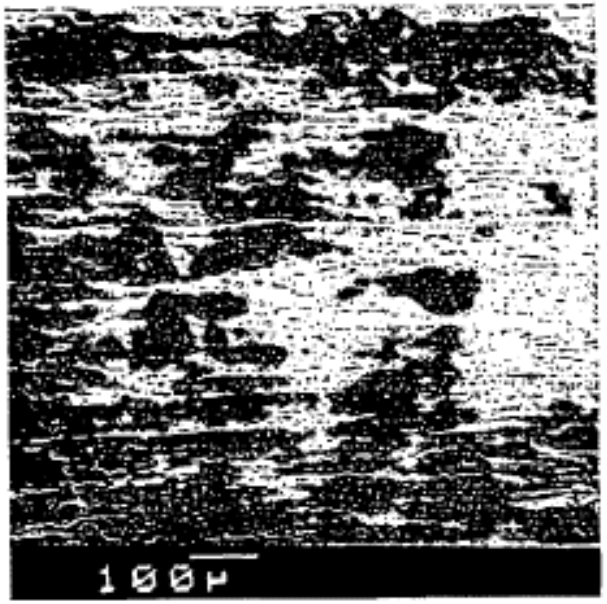


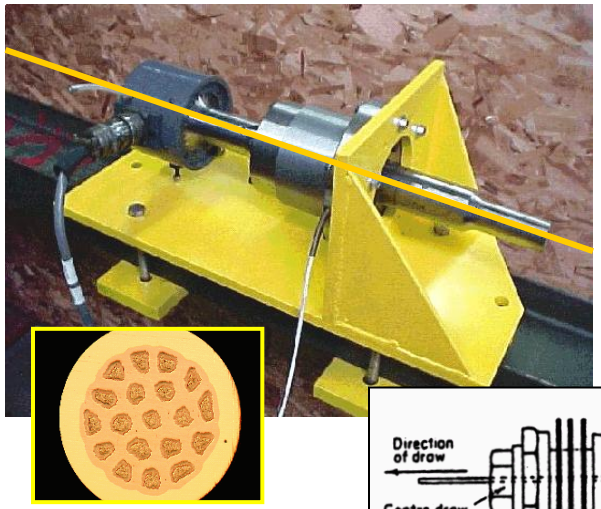
Figure 2

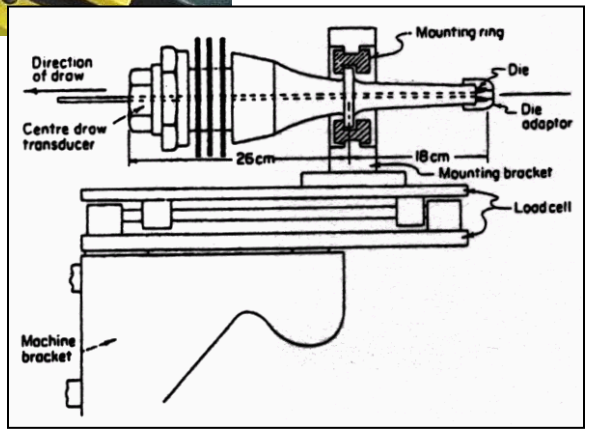
Figure 3

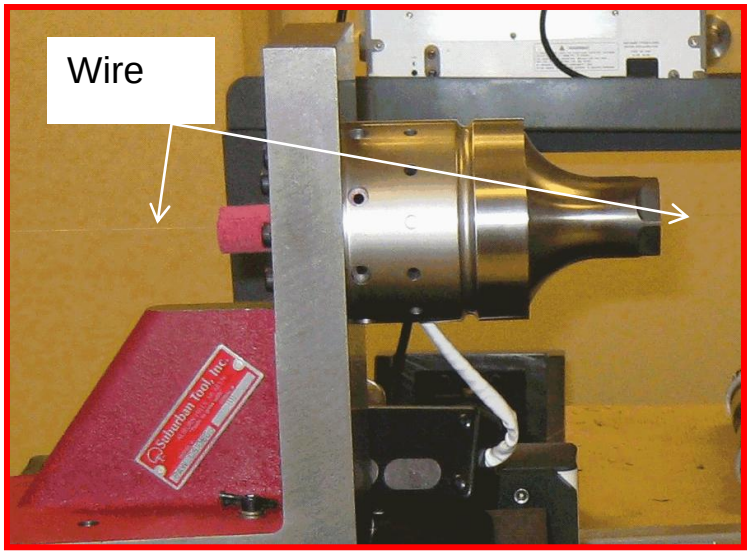
Zust, R, "Wet and dry wire drawing with ultrasonic support," *Wire Industry (UK).* Vol. 67, no. 796 (April 2000), pp. 341-342.

Recent work…

Superconducting composite and fine wire (~0.005” / 36AWG).







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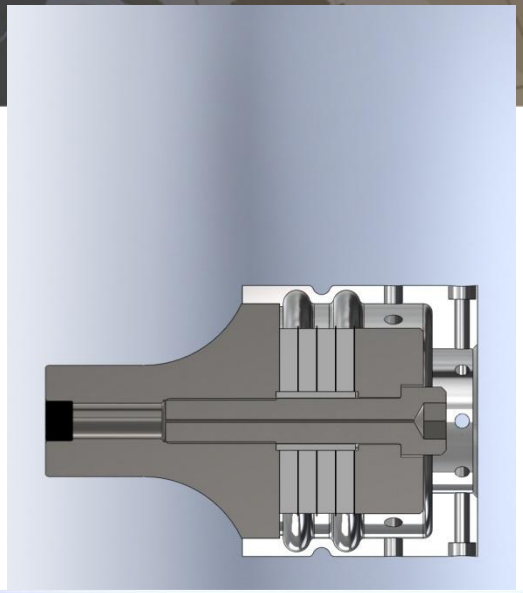
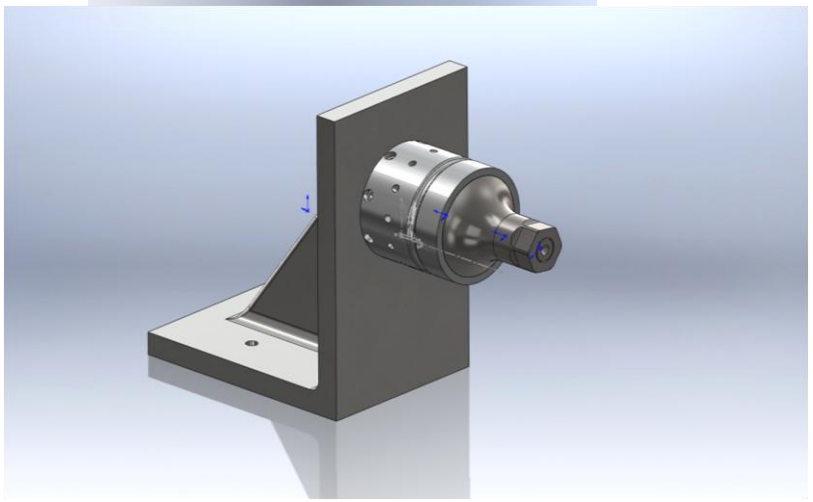
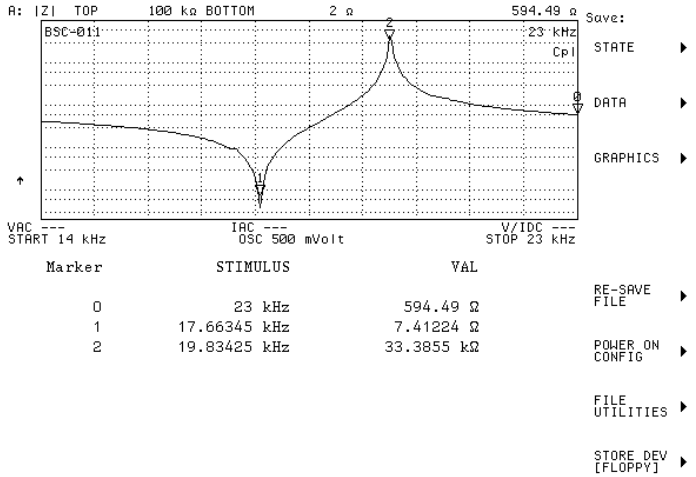
Stack Design

Shrink-fit collet







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Wire Drawing Bench

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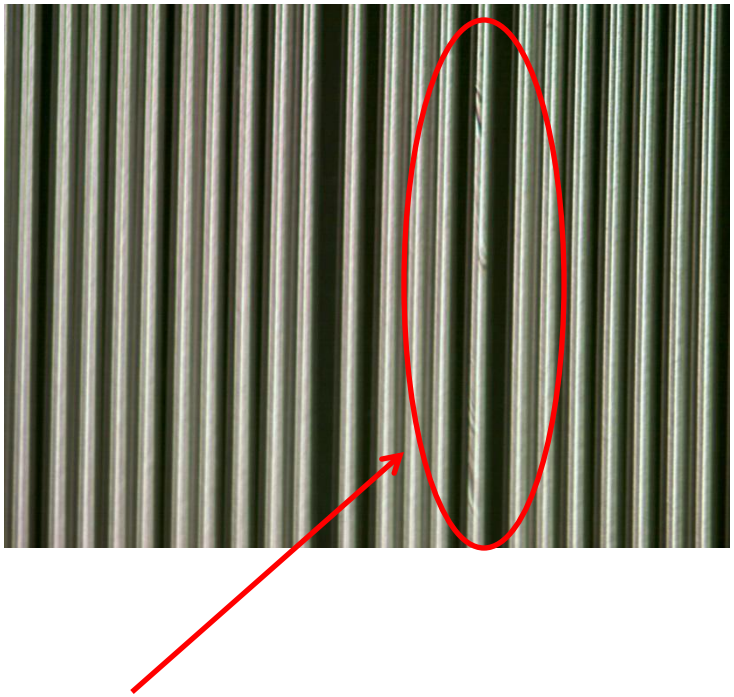
Wire Drawing Experiments

Converting Voltage from Polytec HSV2001 Laser Vibrometer to Amplitude			
2/23/2012			
Frequency	Factor		
kHz			
20	7.958		
Set Amplitude	Laser Vibrometer	>>>	Amplitude
Percent	Volts (pk-pk)	>>>	Microns (pk-pk)
40	0.184		7.3
50	0.218		8.7
60	0.262		10.4
70	0.278		11.1
80	0.300		11.9
90	0.332		13.2
100	0.348		13.8
	0.000		0.0
	0.000		0.0
	0.000		0.0
	0.000		0.0
	0.000		0.0

Amplitude Set	Frequency (p/s)	Power
40	20420	15
50	20450	17
60	20460	22
70	20479	23
80	20487	27
90	20486	31
100	20493	33

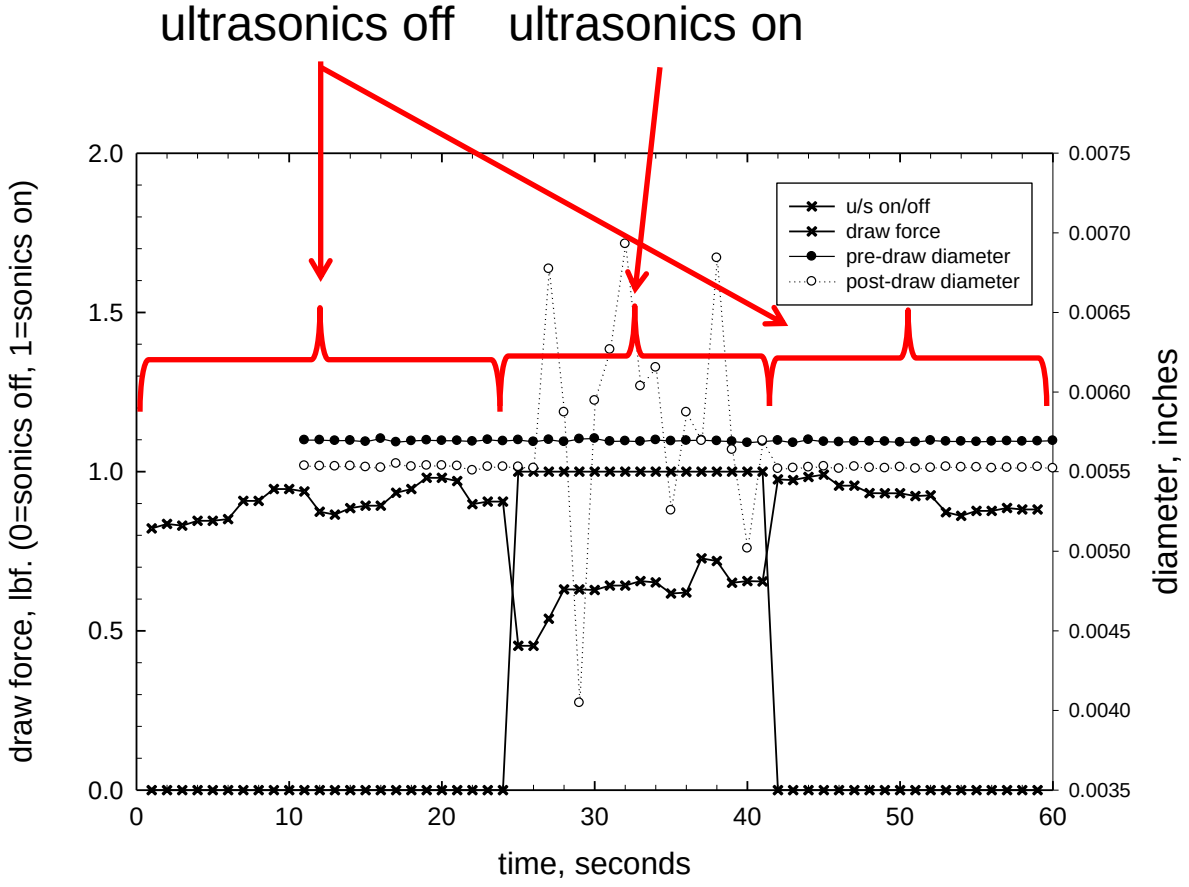
Performance data of stack



Draw marks on as-received wire

Process data

Post-draw diameter could not be measured while ultrasonic energy applied.



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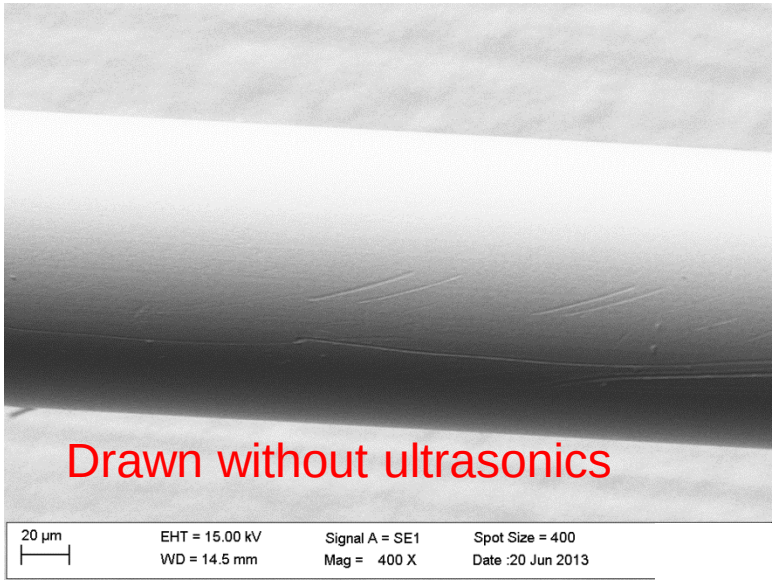
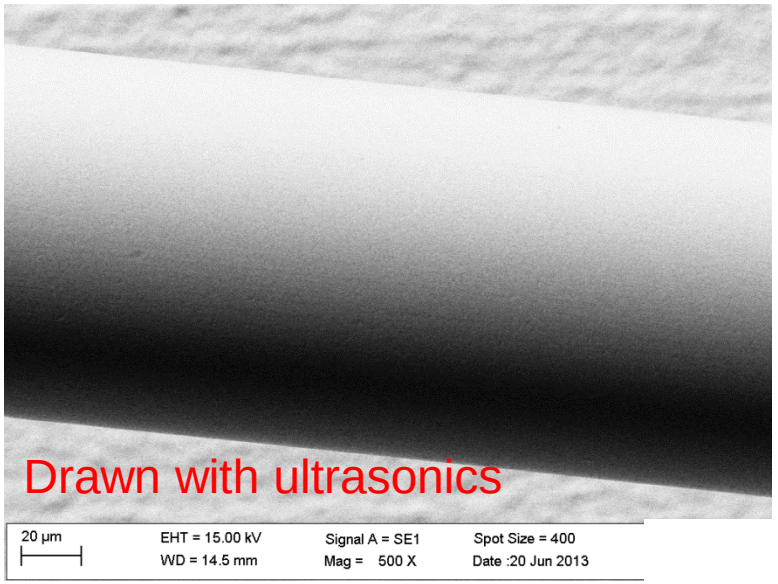
Experimental Results

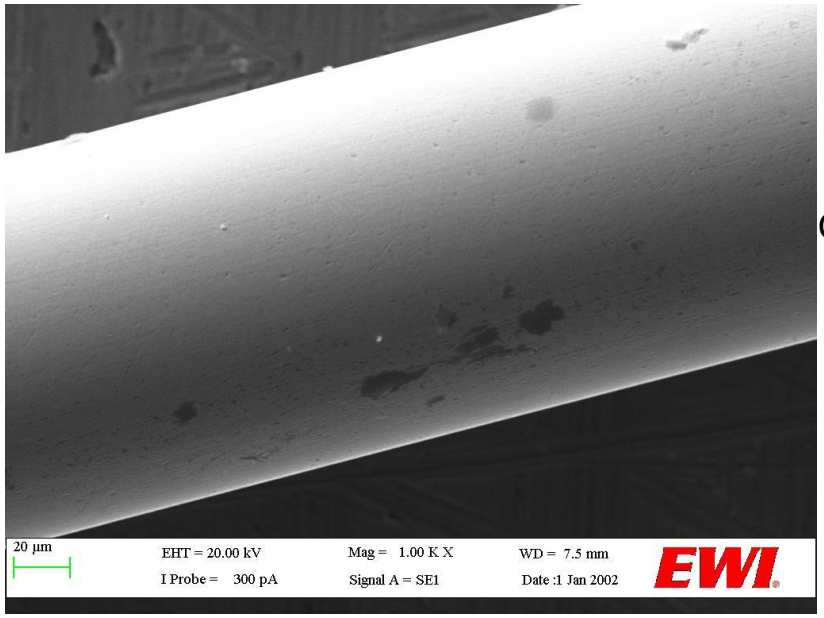
- **Expected results:**
  - Friction reduction, meaning:
    - Faster draw speed
    - Less draw force
    - Reduction in breakage
- **Also observed increased smoothness:**



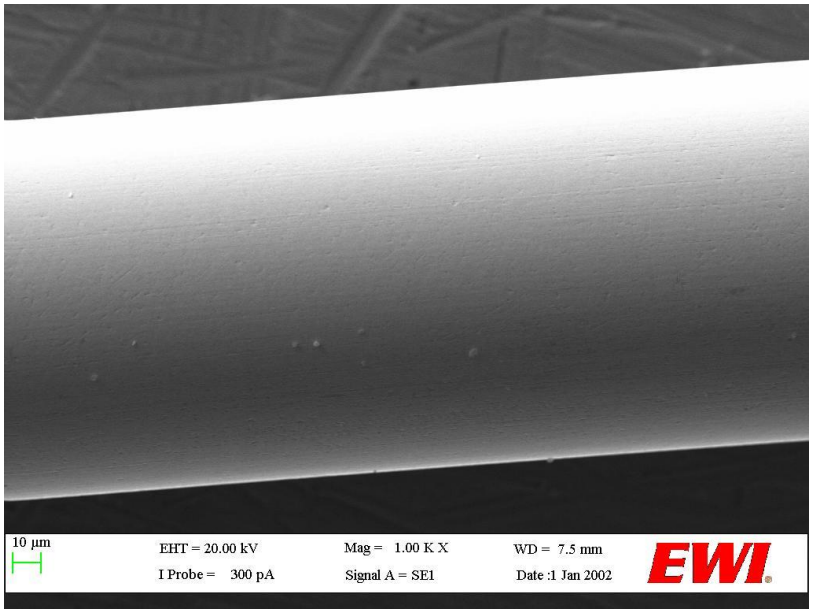


Experimental Results

- **Unexpected results:**
  - Wire resonation – could not measure post-draw diameter
  - But, this “cleaned” the wire
  - Also affected use of lubricant applied



Cleaning
>>>>



Summary

- **Ultrasonic-assisted wire drawing has been researched and equipment developed, by EWI and others.**

- **Data has been reported that shows improvement in:**
  - smoother surface finish
  - faster draw speeds possible
  - lower draw force - ~30%
  - reduction or elimination of draw lubricant

- **Questions?**

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