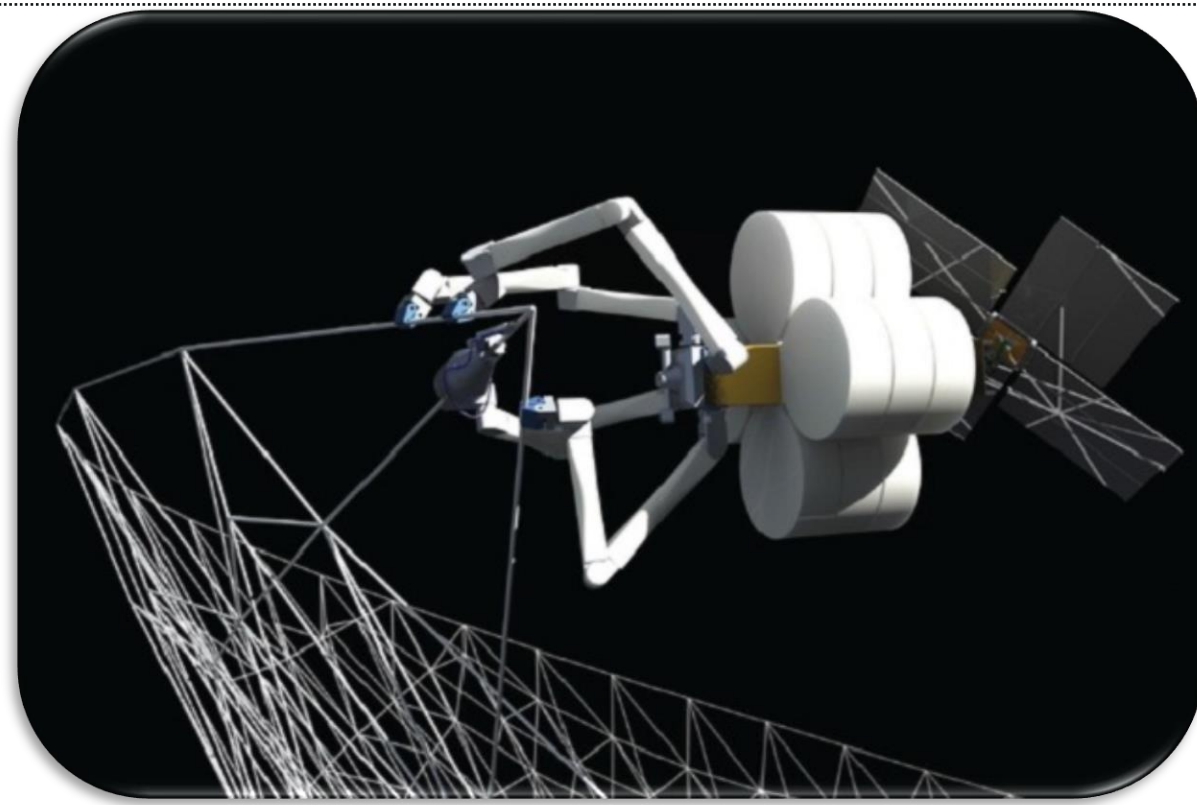
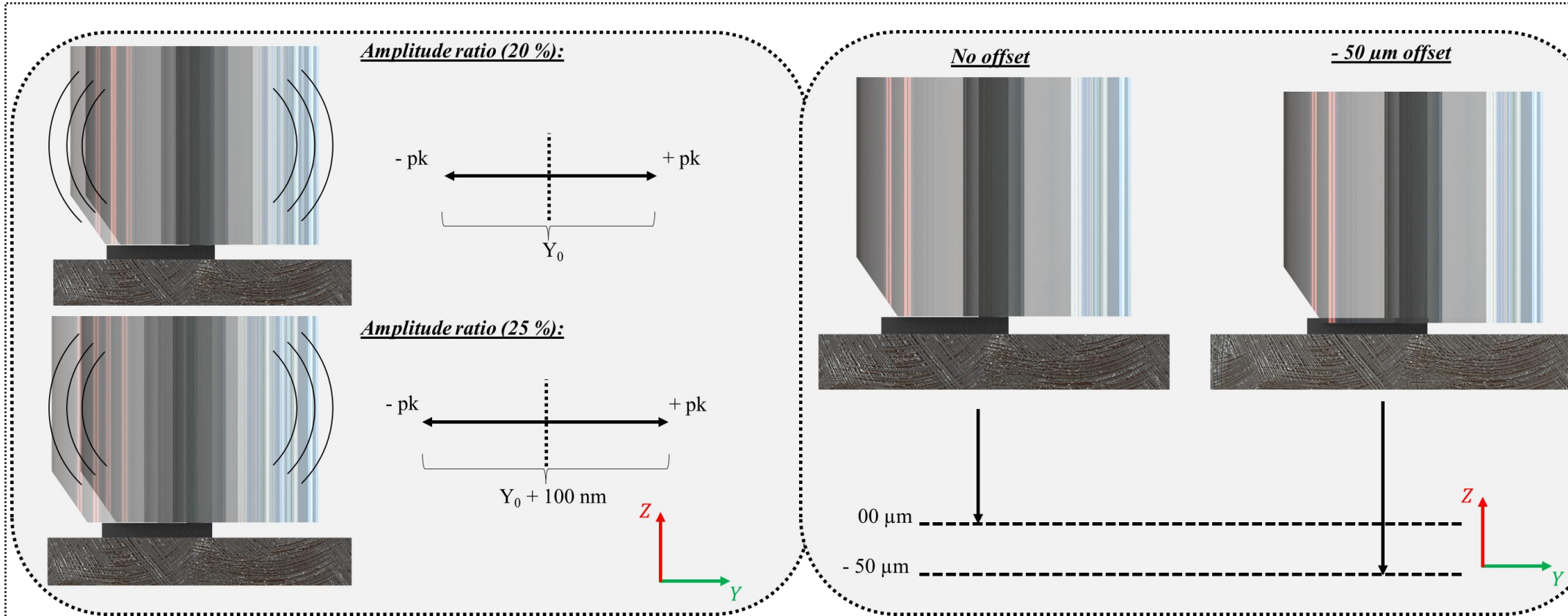
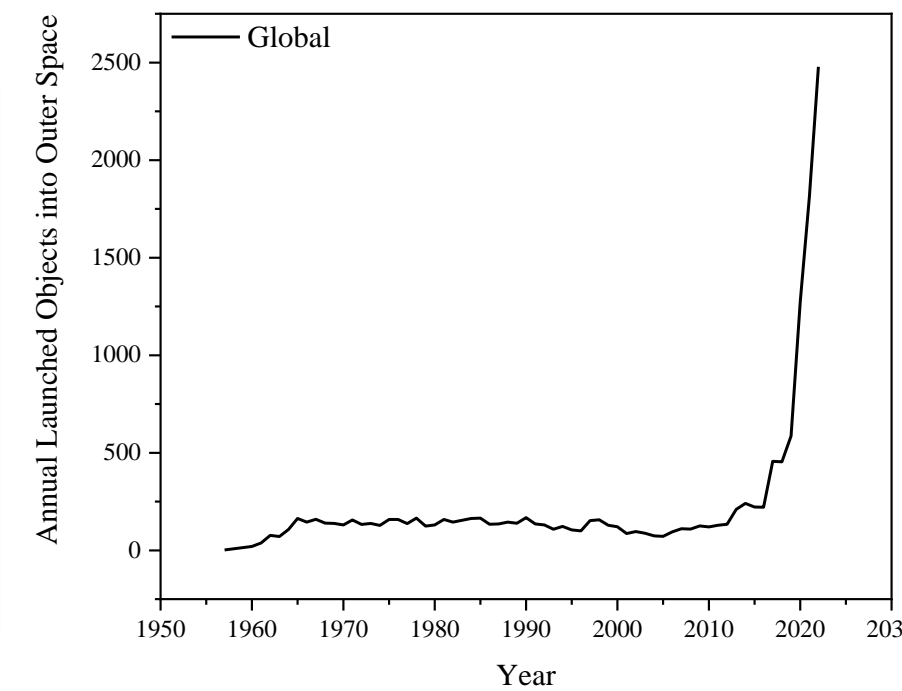


# A study on Aluminum Voxels Characteristics Deposited by a New Metal 3D Printing Method

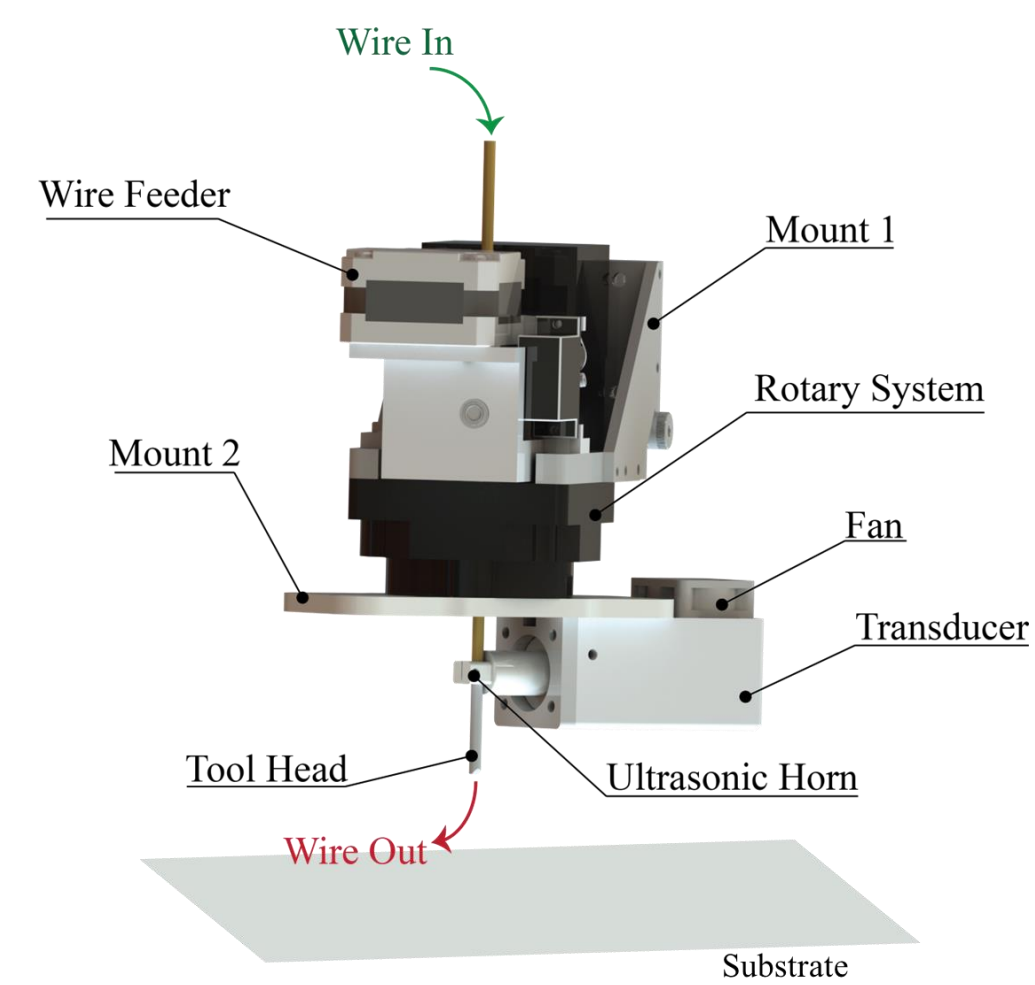
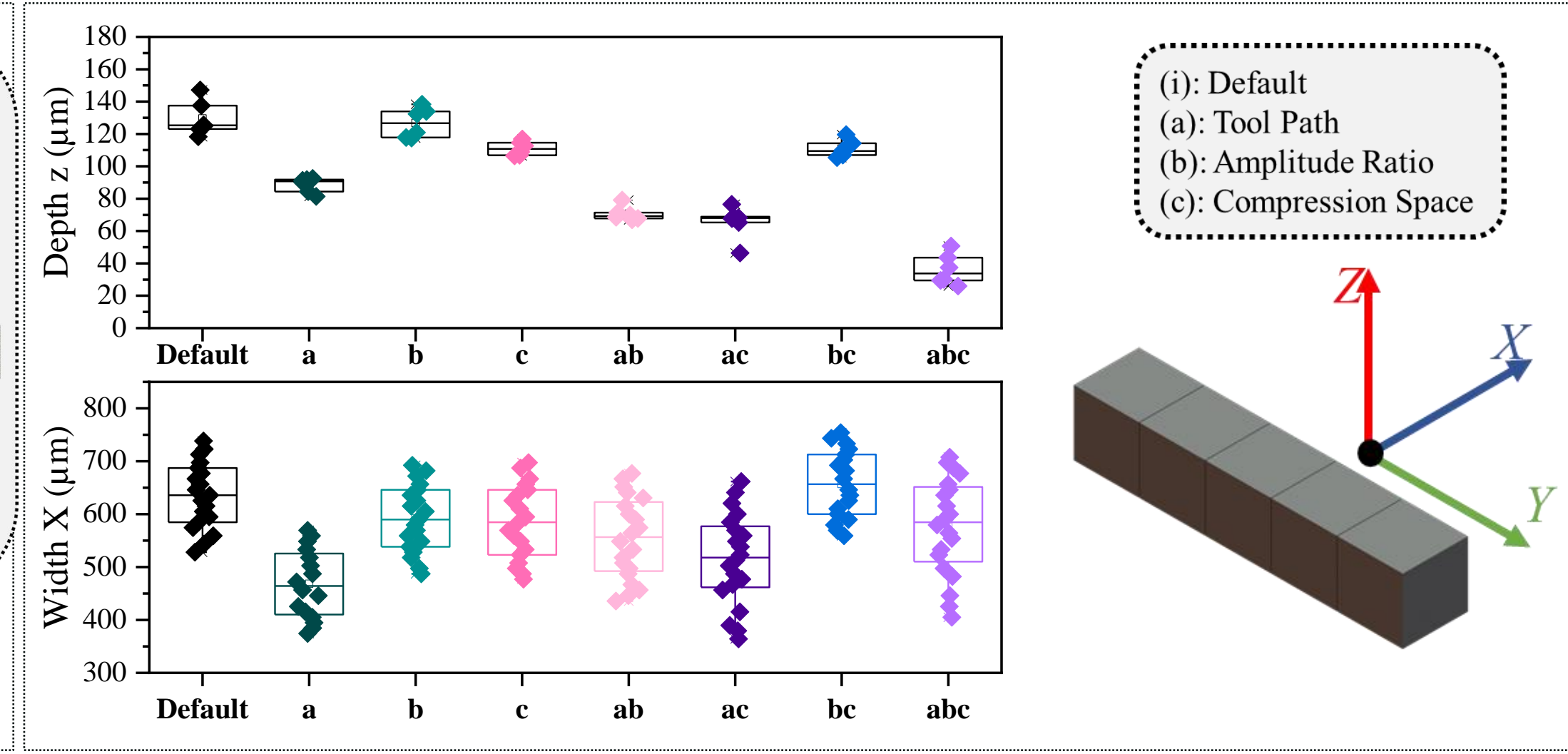
Mohammed Bawareth, Manufacturing Engineering  
Mentor: Keng Hsu, Associate Professor  
School of Manufacturing Systems and Networks



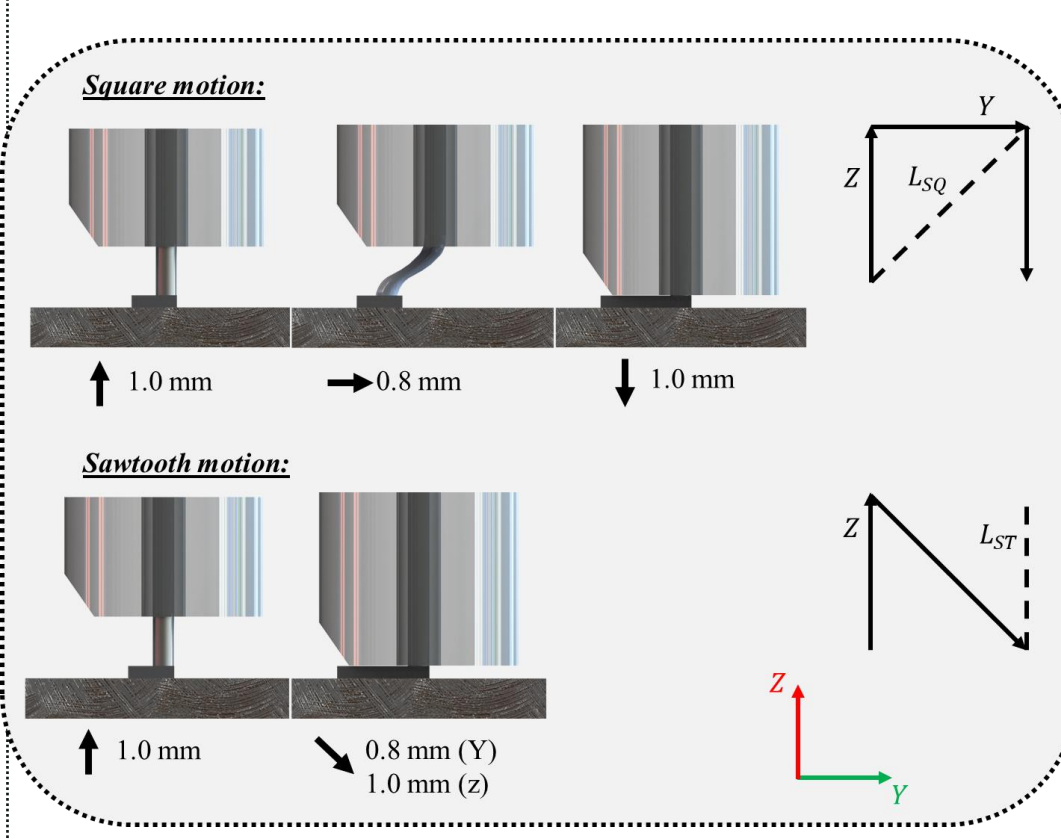
IS Metal Additive Manufacturing technology possible and important for space manufacturing?



Vibration Amplitude      Compression

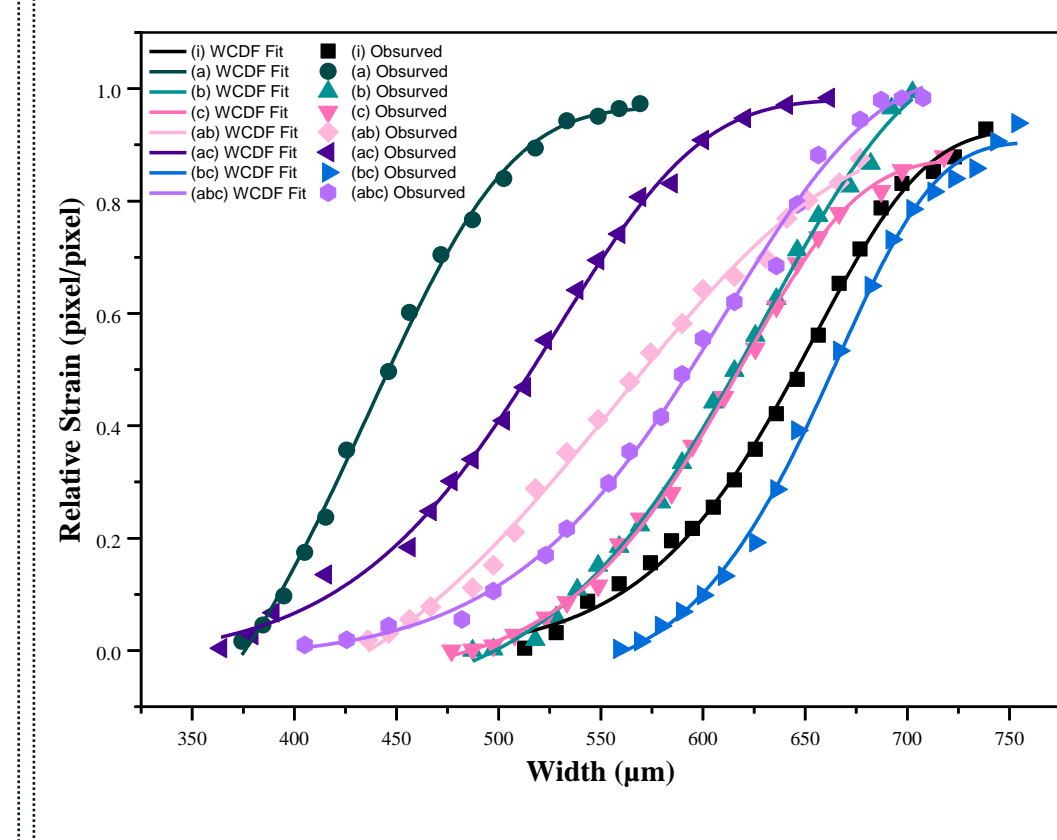


- Metal wire with 350 μm.
- Mount 1 is connected to a coordination control system.
- A piezoelectric transducer connected to a frequency generator.
- Tool Head: it must be made from strong material.
- Substrate: is above a hotbed.

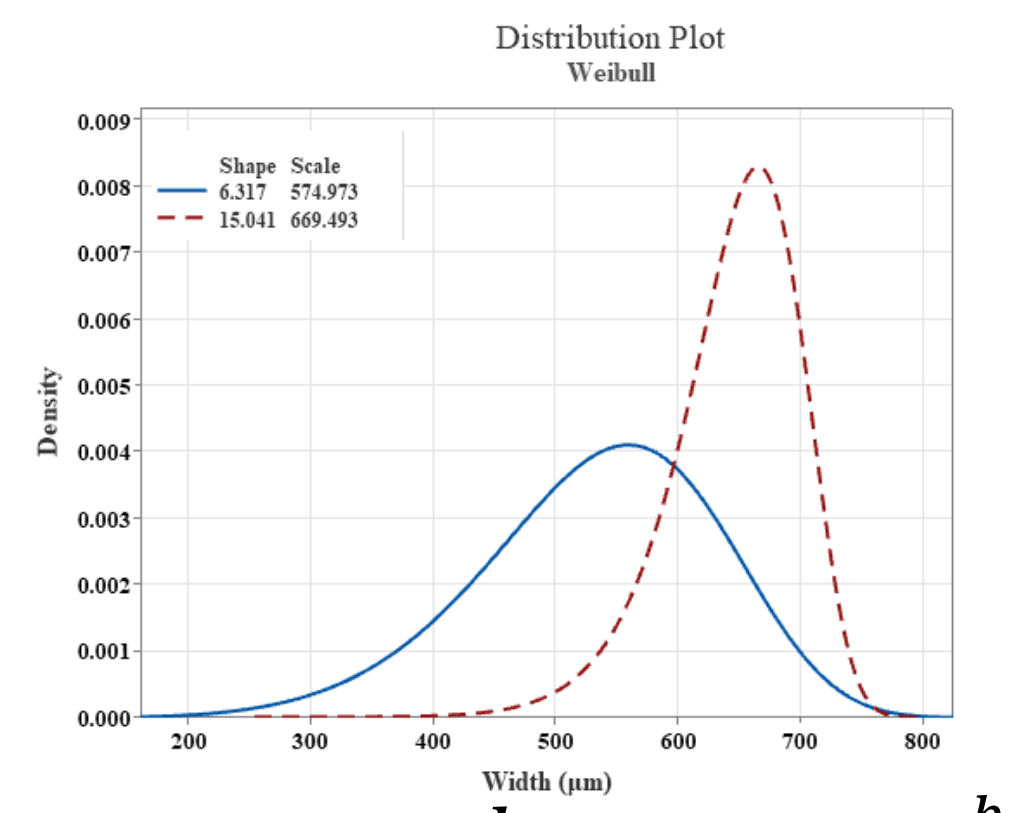


Tool Path

| Run | Treatment             | Factors |    |    |
|-----|-----------------------|---------|----|----|
|     |                       | a       | b  | c  |
| 1   | Default (i)           | -1      | -1 | -1 |
| 2   | Tool path (a)         | +1      | -1 | -1 |
| 3   | Amplitude Ratio (b)   | -1      | +1 | -1 |
| 4   | Compression Space (c) | -1      | -1 | +1 |
| 5   | ab                    | +1      | +1 | -1 |
| 6   | ac                    | +1      | -1 | +1 |
| 7   | bc                    | -1      | +1 | +1 |
| 8   | abc                   | +1      | +1 | +1 |



$$y = y_0 + A_1 \left[ 1 - e^{-\left(\frac{x}{a}\right)^b} \right]$$



$$f(t) = \frac{b}{a^b} x^{b-1} e^{-\left(\frac{x}{a}\right)^b}$$

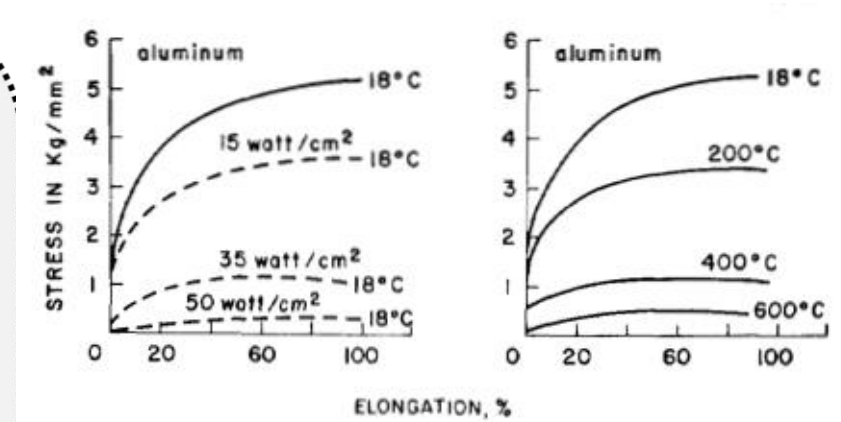
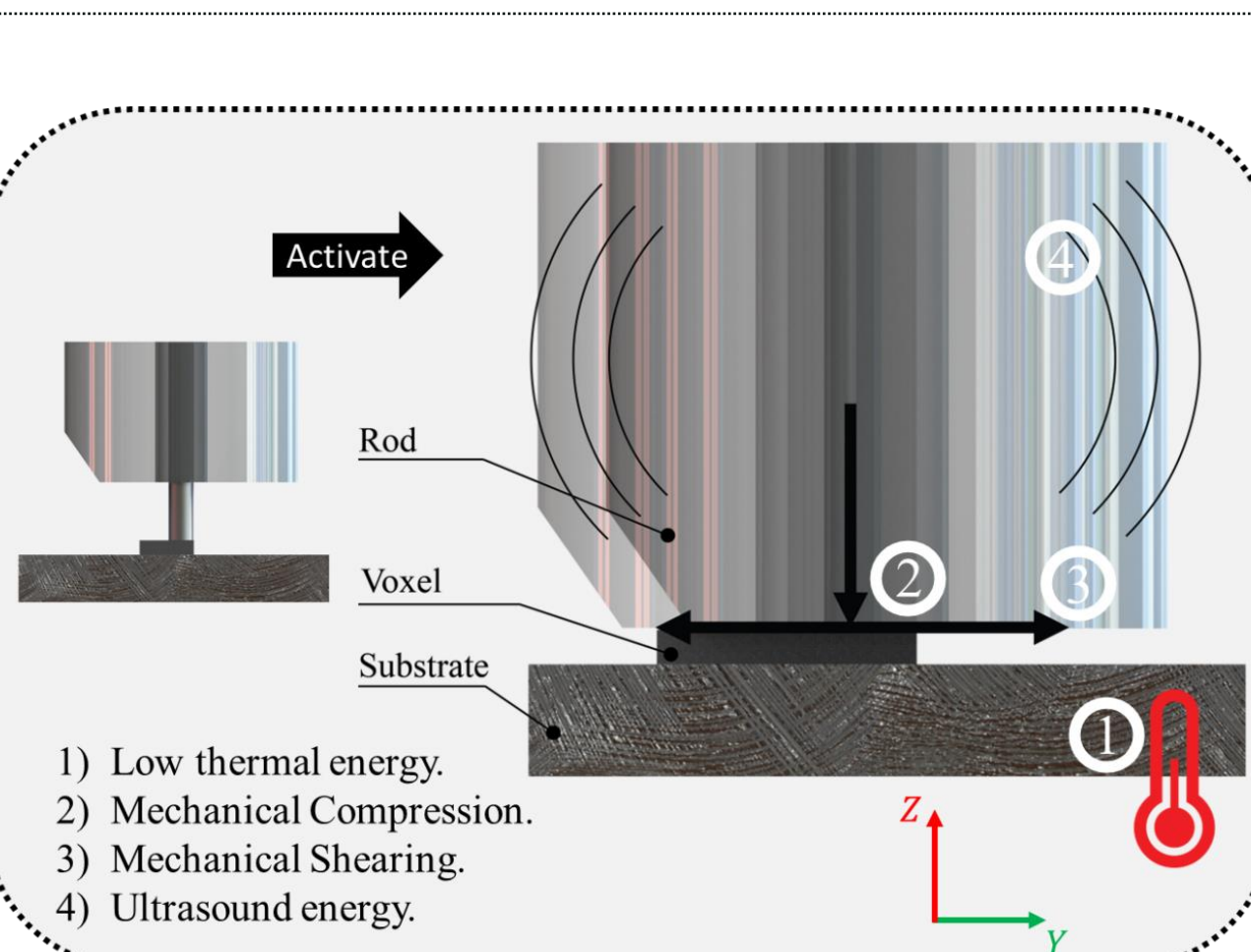
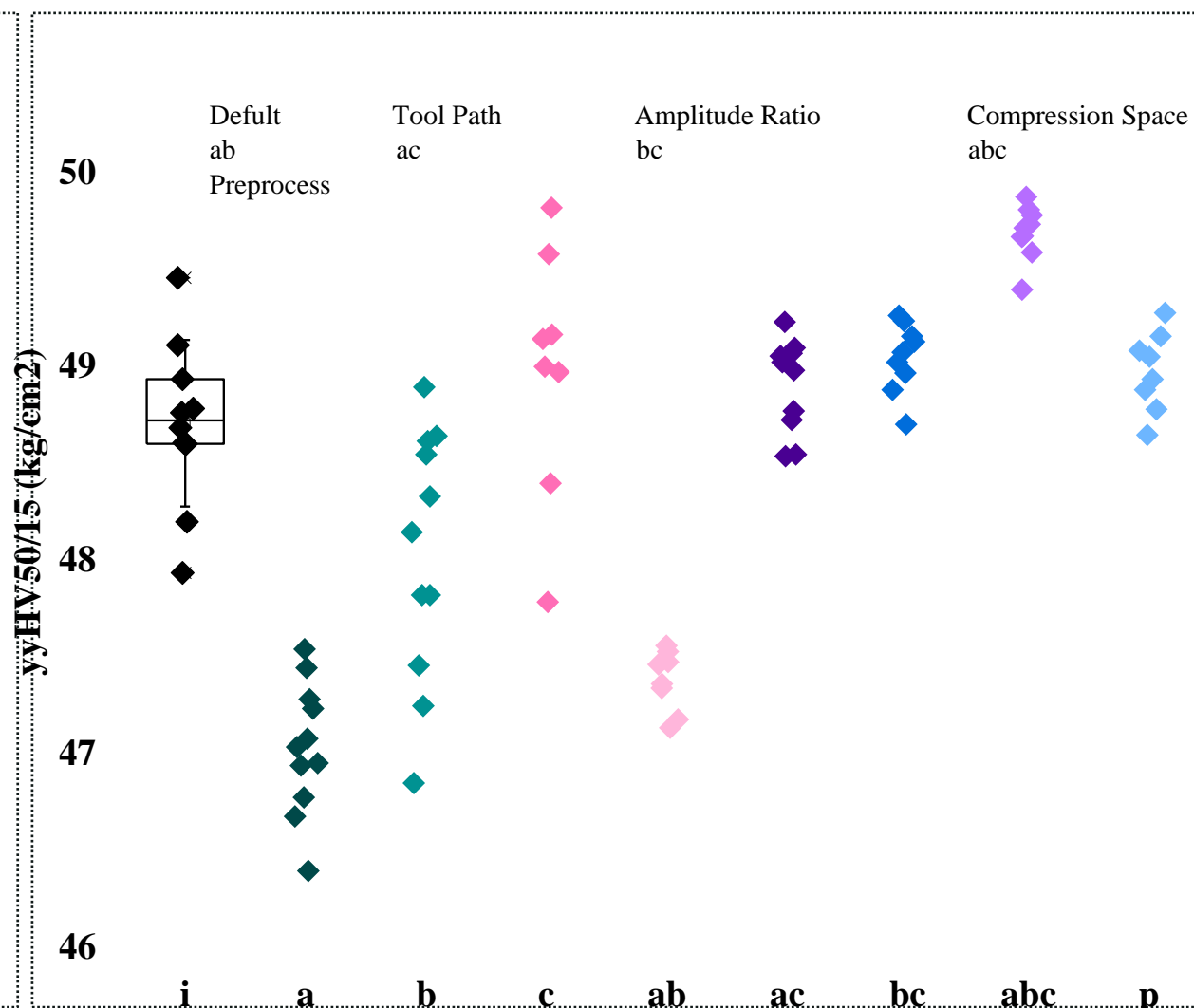


Fig. 1. Stress vs. elongation for aluminum single crystals; dashed curves indicate straining during ultrasonic irradiation at 20 ke/s and solid curves indicate no irradiation.

B. Langenecker, "Effects of Ultrasound on Deformation Characteristics of Metals," in *IEEE Transactions on Sonics and Ultrasonics*, vol. 13, no. 1, pp. 1-8, March 1966. doi: 10.1109/T-SU.1966.29367.

| Printing Parameters   | Value                     |
|-----------------------|---------------------------|
| Wire Material         | 99% Al, 1% Si             |
| Substrate Material    | 6061-T6 Al                |
| Wire Diameter         | 340 μm                    |
| Substrate Dimension   | 10X10X0.5 cm <sup>3</sup> |
| Substrate Temperature | 100 °C                    |
| Frequency             | 58.00 kHz                 |



| Pair    | Mean     | One-Sided p |
|---------|----------|-------------|
| p - ab  | 1.59551  | 0.000       |
| p - a   | 1.83120  | 0.000       |
| p - abc | -0.72093 | 0.000       |
| p - b   | 0.74077  | 0.012       |
| p - i   | 0.32831  | 0.069       |
| p - bc  | -0.11483 | 0.103       |
| p - ac  | 0.00568  | 0.479       |
| p - c   | -0.00673 | 0.490       |

Data Analysis:  
➢ There is a significant statistical difference, but the mean difference is one magnitude less than the mean value.  
❖ We can't say there is a meaningful difference.