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Abstract

In this project, Bessel beams are generated from Gaussian beams with an axicon. Then, Bessel beams are utilized to conduct glass welding. Comparing with Gaussian beam, it has been proved that Bessel beam has larger focal-position tolerant zone for glass welding. Here, we generate Bessel beam and measure its beam profile. In the future, we are going to conduct glass welding with Bessel beam and compare the result with Gaussian beam.

Theory

1. How to conduct glass welding?

Utilize fs laser: Nonlinear absorption

→ Multi-photon absorption & Avalanche ionization

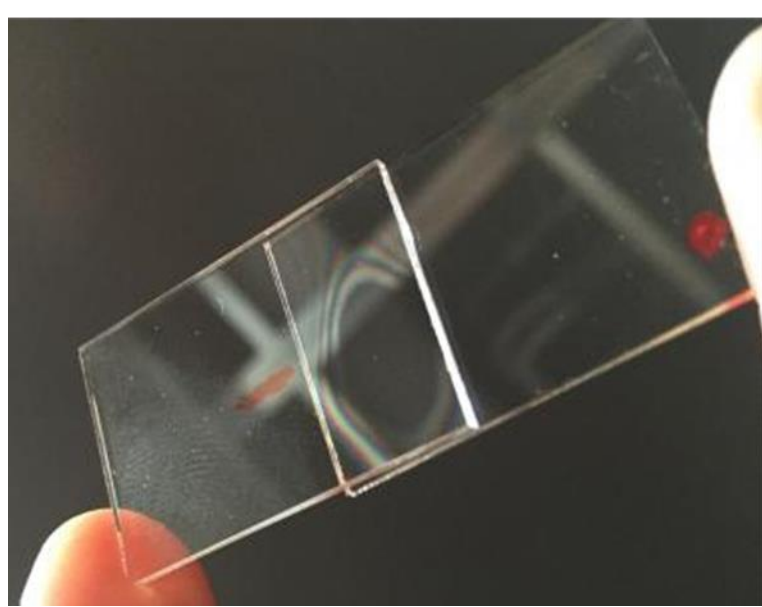


Fig. 1 Glass welding^[1]

2. Gaussian beam was used for glass welding, but Gaussian beam has smaller tolerant range.

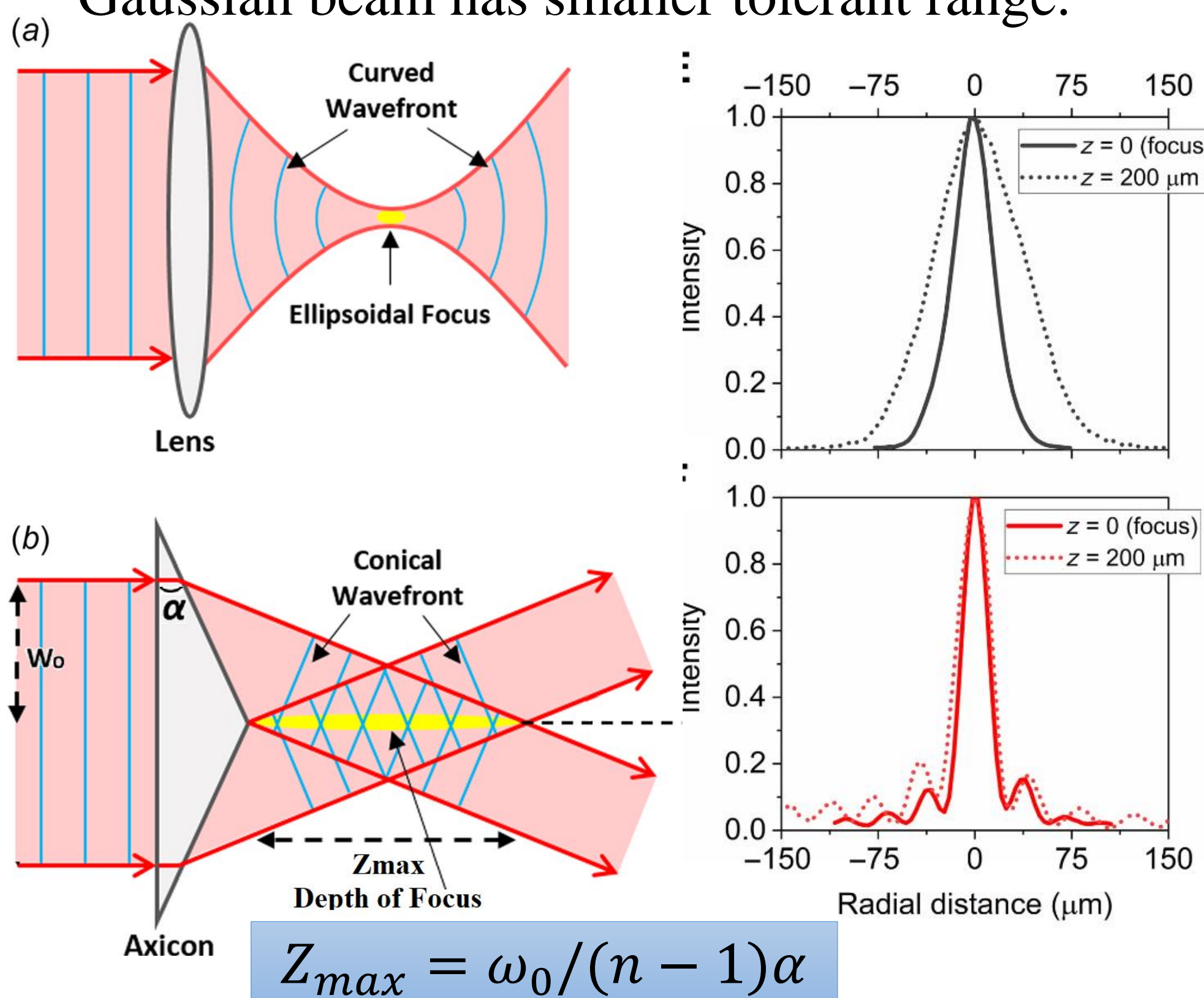


Fig. 2 Diagram comparing Gaussian beam and Bessel beam.^{[2][3]}

3. How to generate Bessel beams?

Use axicon → Interference

Setup

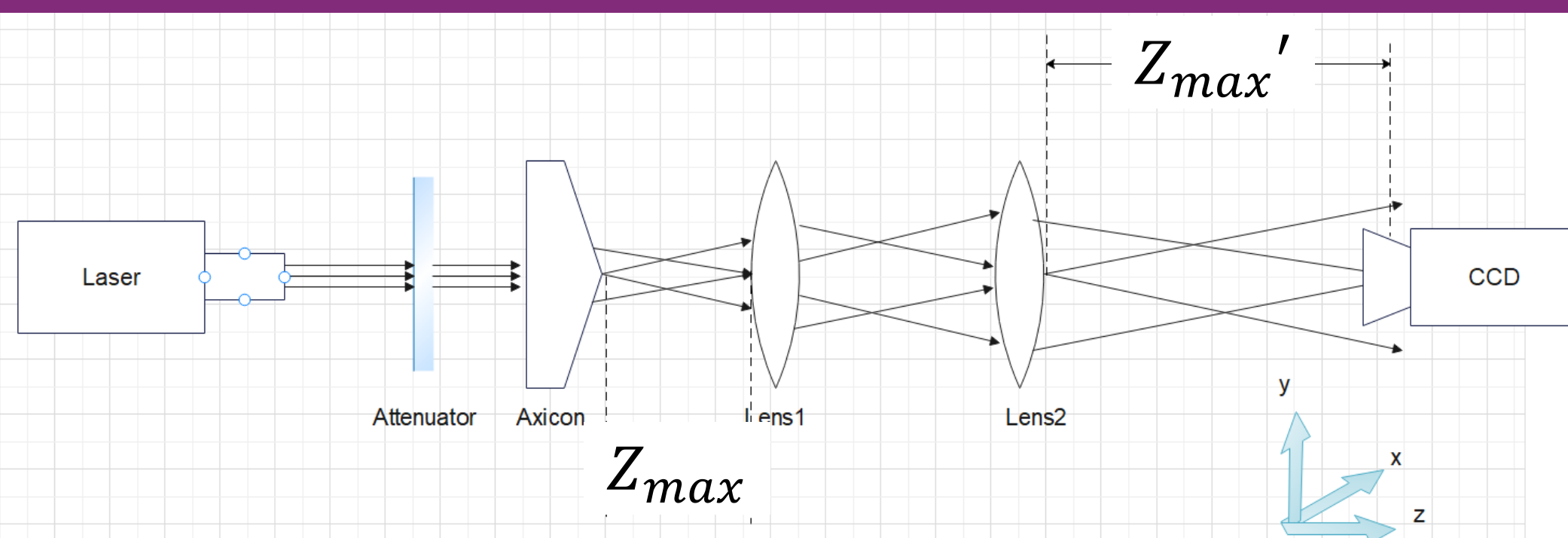


Fig. 3 The setup: IR pulse laser (1030 nm ; $\omega_0 = 1.1\text{mm}$) ; Axicon ($n = 1.458$; $\alpha = 10^\circ$) ; Lens pair: 7.5cm & 60 cm ; $Z_{max} = 1.38\text{ cm}$; $Z_{max}' = 88\text{ cm}$

Result

First, we use CCD to measure the beam profile. As shown in Figure 4 (left), the cross section of the beam consists of several concentric rings, presenting intensity profile as Bessel function.

Then, the beam intensity distribution along optical axis is measured. Figure 4 (right) shows the longitudinal section of the beam presents elongated distribution, and the length of non-diffracting region is about 70 cm.

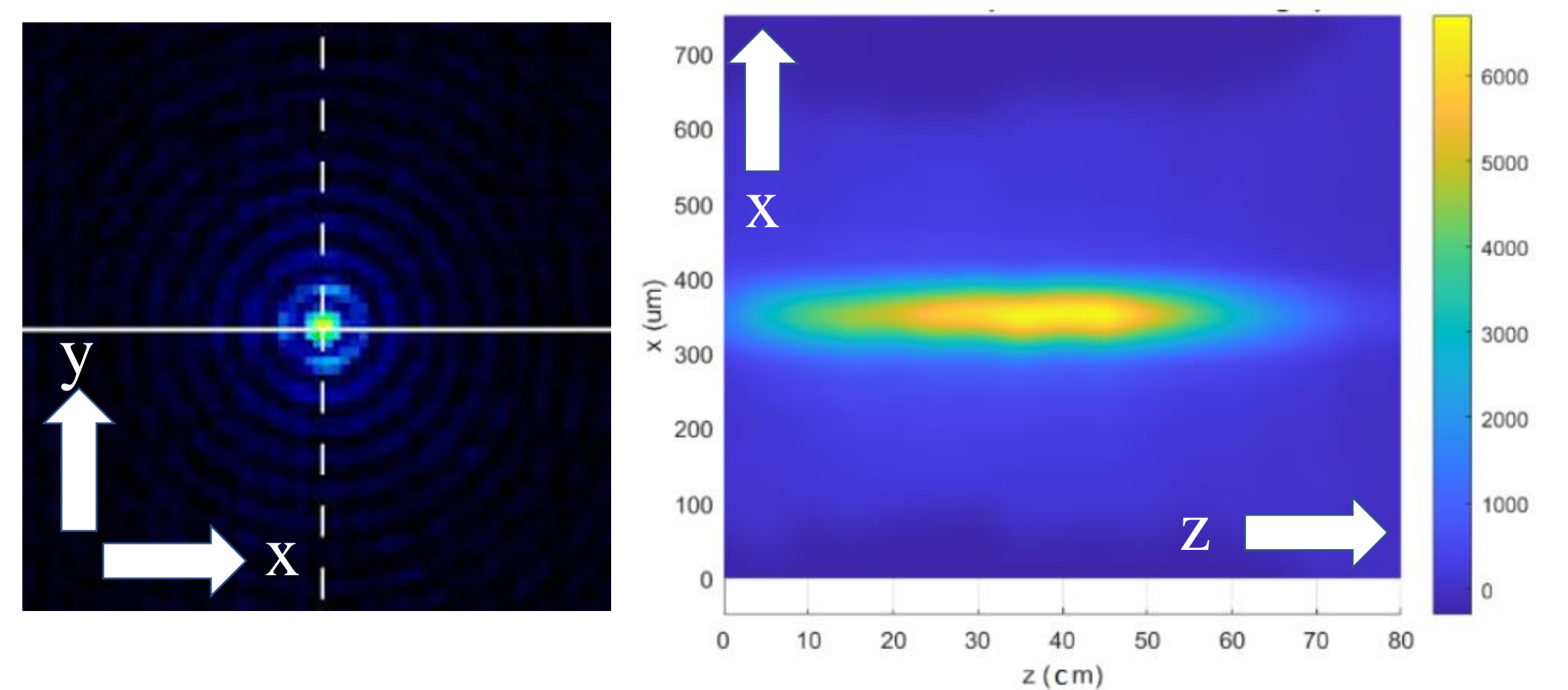


Fig. 4 (left) The beam profile of x-y plane; (right) The beam profile of x-z plane.

Conclusion & Future Work

1. Laser expanding may cause experimental error.
2. Bessel beam has been already generated by an axicon with larger depth of focus.
3. Glass welding will be conducted soon, and the result will be compared with Gaussian beam.

Reference

1. <https://www.alphanov.com/en/collaborative-projects/femtoweld-glass-welding-and-cutting>
2. Xiaoming Yu, Meng Zhang, Shuting Lei, "Multiphoton Polymerization Using Femtosecond Bessel Beam for Layerless Three-Dimensional Printing," Journal of Micro and Nano-Manufacturing, Vol.6, Issue 1, Mar. 2018, p.010901-2
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