

# ADVANCED MATERIALS

## Supporting Information

for *Adv. Mater.*, DOI: 10.1002/adma.202208653

Entering a New Dimension in Powder Processing for  
Advanced Ceramics Shaping

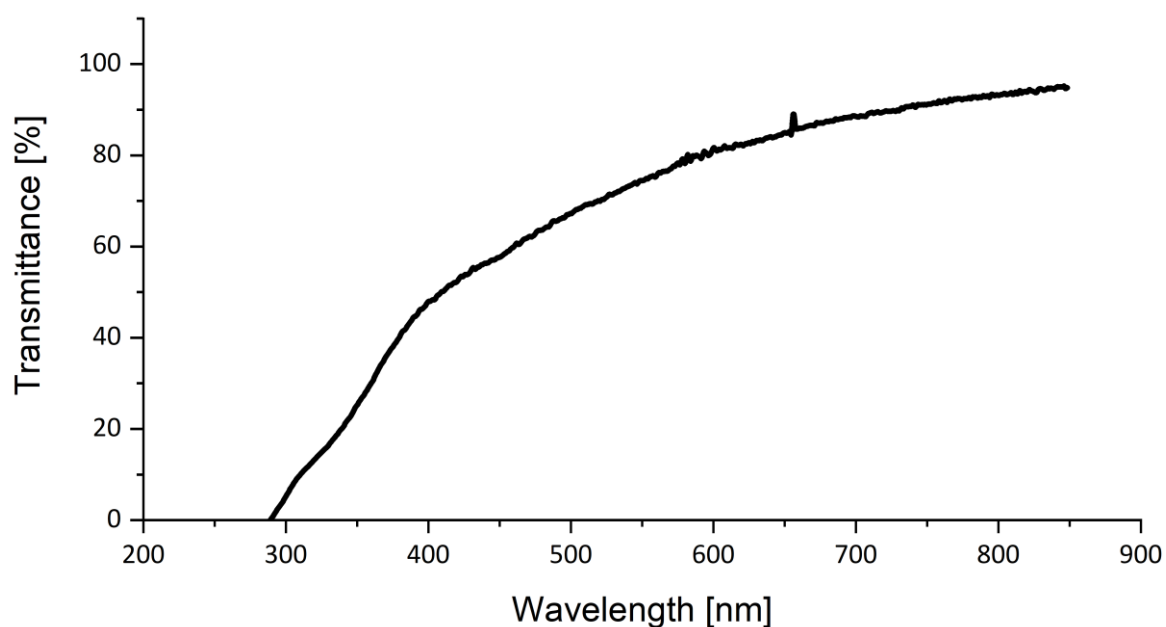
*Johanna Christiane Sanger,\* Brian Richard Pauw, Birte  
Riechers, Andrea Zocca, Julian Rosalie, Robert Maa,  
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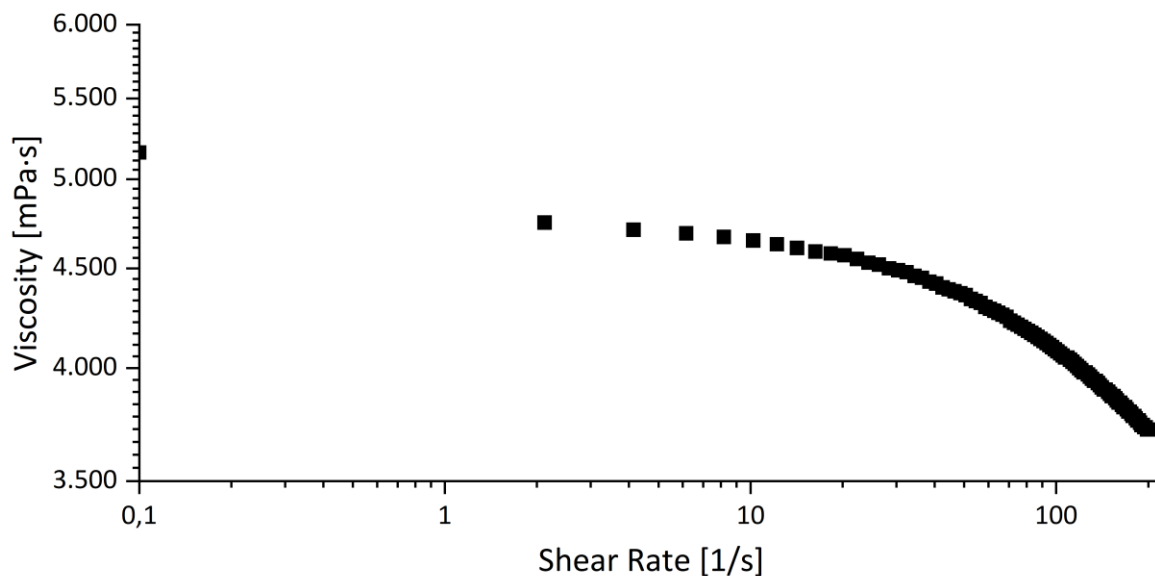
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*Transmittance of Uncured Resin:* The full transmittance curve of the used uncured resin at 70wt% solid loading is shown in **Figure S1**. The transmittance at the 2PP relevant wavelength of 800nm is above 90%, which is sufficiently high for 2PP-structuring.



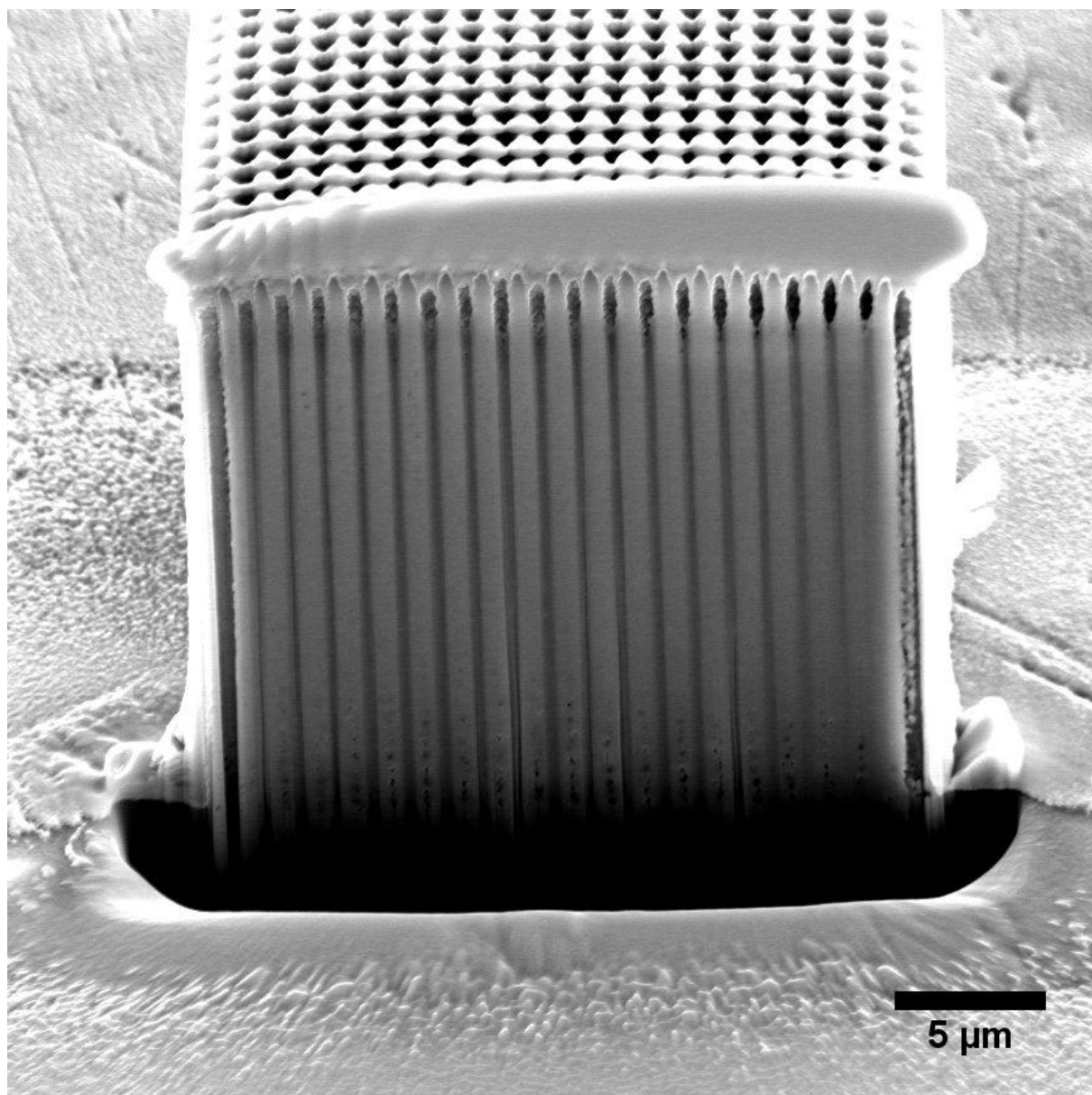
**Figure S1. Transmittance curve of the ceramic particle containing resin with 70wt% solid loading as a function of incident light wavelength.**

*Viscosity of resin:* **Figure S2** is showing a flow curve of the 70wt% solid load resin. It shows shear thinning behavior, which is common for stereolithography resins and the overall viscosity is just appropriate for 2PP-processing.



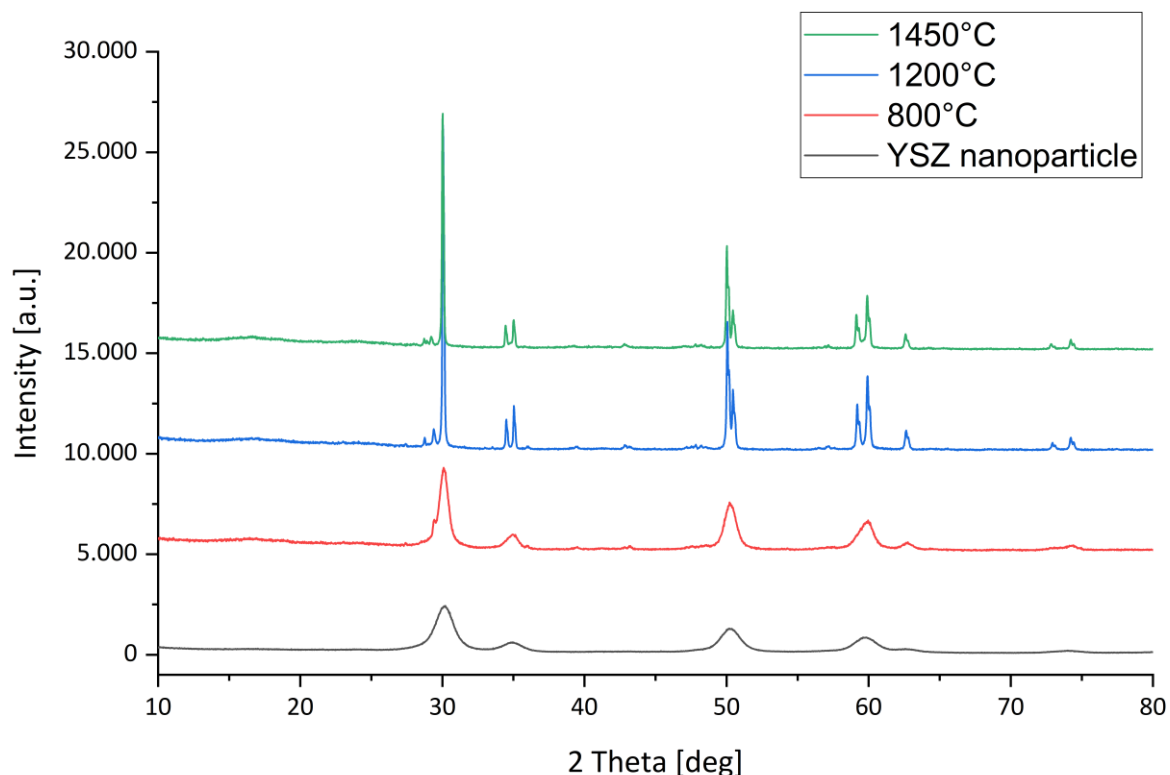
**Figure S2. Flow curve of 70wt% resin.**

*Resolution of hollow 2PP-printed Cube:* The inner structure of hollow structures is revealed by a FIBS-cross section (**Figure S3**). The pillars of 500nm, which are visible from the top, penetrate down to the bottom. The clear outlines are visible, proving that washing and drying steps to get rid of uncured resin were successful.



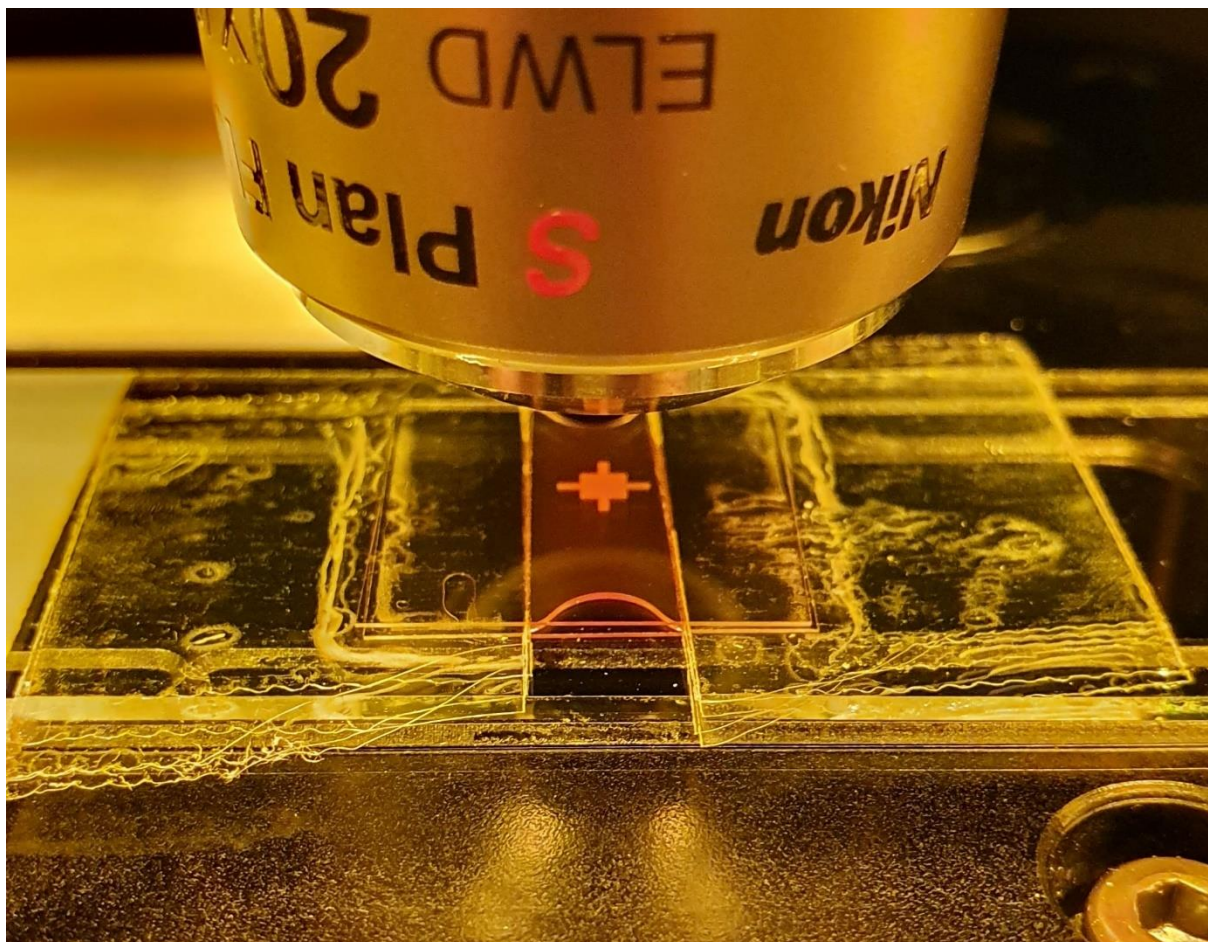
**Figure S3. FIBS-cross section of hollow printed cube.**

*Phase analysis of materials:* At all stages of the material processing x-ray diffraction analysis XRD has been performed. The suspension as received has been dried to a powder and characterized. With this suspension a photocurable resin has been synthesized, UV cured, sintered at different temperatures, and characterized regarding its phase assemblage. For all samples, shown in **Figure S4**, only the tetragonal phase of the yttria stabilized (3mol%) zirconia can be recognized. As expected, for the raw material nanoparticles, the signal is relatively weak and peaks are broadened. The sintered material generally provides sharp peaks.



**Figure S4. bottom, XRD measurements of the raw material (dried suspension as received), and sintered material (crosslinked resin and sintered at 800°C, 1200°C, 1450°C).**

*2PP Printing Range Extension:* 2PP printing is the additive manufacturing technology of choice for highest accuracy and resolution. However, this comes with a relatively slow printing speed. On the other hand, the usage of a long-range objective and adjusted printing parameters together with sophisticated stitching technologies allow in modern setups to address areas as large as some mm<sup>2</sup>. The used Fentika 2PP machine provides this up-to-date technology. The following example shows a sample with 4mm lateral size and a height of 50µm, which was printed within one day from the 70wt% YSZ resin (**Figure S5**). Moreover, combining conventional stereolithography with 2PP, is another possible approach to generate larger parts with complex high-resolution entities.



**Figure S5. 4mm large 2PP written structure from YSZ-resin with 70wt% nanoparticles.**