## Femtosecond Laser Fabrication of High Precision Three-dimensional Woodpile Photonic Crystals and Their Near-field Characterisation

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**Abstract**— The femtosecond laser facilitated two-photon polymerisation (2PP) technique is a power fabrication tool for various arbitrary shaped micro-optical devices, among them photonic crystals (PCs) representing a hot topic [1]. Due to their unique optical properties and potential capability to miniaturise optical system, three-dimensional (3D) PCs have attracted much interest in the last two decades. Various fabrication techniques have been proposed and demonstrated. However challenge remains when near-infrared (NIR) or visible PCs compatible with the current telecommunication infrastructure are fabricated because periodicities comparable to the wavelength of illumination light have to be achieved. In this paper, by using the femtosecond laser facilitated 2PP technique, high precision 3D polymer woodpile PCs possessing NIR ( $\sim 1.1 \,\mu m$ ) bandgaps with nearly 100% suppression in transmission have been achieved. The NIR photonic bandgaps can be continuously tuned to a shorter wavelength region by employing a thermal annealing process, and eventually leads to woodpile PCs having bandgaps at a wavelength shorter than 1 µm. To characterise the 3D PCs and to optimise the fabrication process, near-field optical microscopy has been employed to obtain both the morphology and optical properties of the PCs simultaneously. The experimental results demonstrate that the near-field measurements provide significant additional information about the optical properties of the devices, which has been previously inaccessible [2].

## REFERENCES

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