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Short-pulse laser-assisted fabrication of a hybrid Si-SiO₂ microcooling device

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Thermal management is one of the main challenges for the most demanding detector technologies and the future of electronics. Microfluidic cooling has been suggested to provide a fully integrated solution to the heat dissipation problem. Traditional manufacturing of silicon-based microfluidic devices is a complex, multi-step process involving advanced, lithography-based techniques for surface patterning. This results in the limited availability of facilities and important production costs that prevent widespread development and use. We demonstrate the relevance of direct laser writing to advantageously replace the tedious lithographic steps and provide a more prototype-friendly process flow. The process is validated in the case of a microfluidic device used for cooling (Figure 1). We use a 20W infrared laser with a pulse duration of 50ps to engrave and drill a 525µm-thick silicon wafer. Anodic bonding to a SiO₂ wafer is used to encapsulate the patterned surface and mechanically clamped inlet/outlet connectors result in a fully operational microcooling device. Our approach constitutes a modular microfabrication solution that should allow more accessible prototyping when co-designing emerging electronics and microfluidics [1].

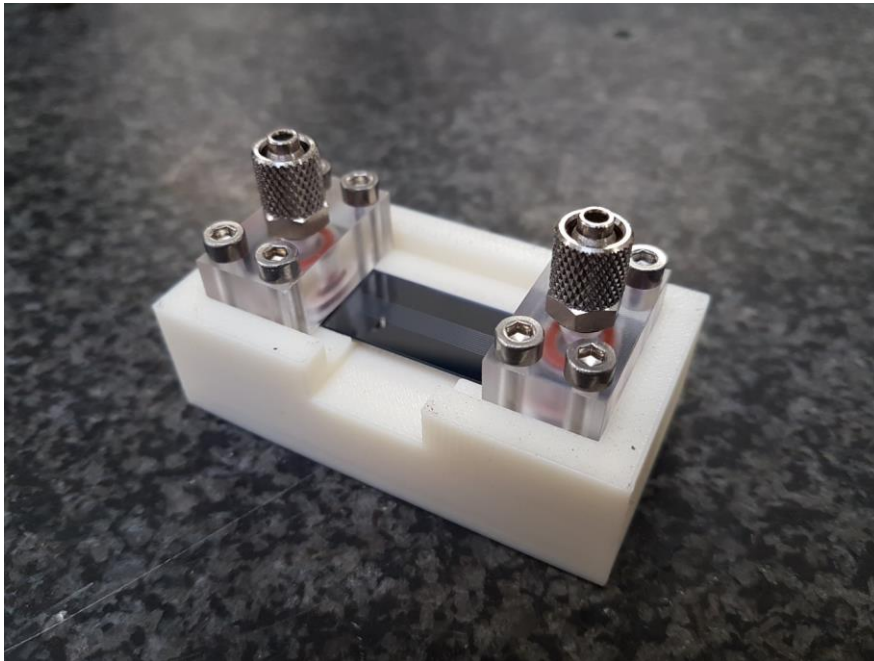


Figure 1. A hybrid Si-SiO₂ microfluidic device patterned by ultrashort pulse laser.

[1] Van Erp, R., Soleimanzadeh, R., Nela, L., Kampitsis, G. & Matioli, E. Co-designing electronics with microfluidics for more sustainable cooling. *Nature* **585**, 211–216 (2020)