Reconfigurable Laser-Written Integrated Photonic Circuits for Linear Optical Quantum Computing

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We present an architecture of fully reconfigurable universal multiport optical circuits on a glass chip. We demonstrate a 4-by-4 multiport thermooptically tunable interferometer fully fabricated using the femtosecond laser writing technology. Currently lithography is the technological standard for fabricating complicated reconfigurable photonic circuits. However, femtosecond laser writing provides the capability of very fast and cheap prototyping of both passive and active integrated photonic chips directly in the optical lab. Here we demonstrate that this technology is capable of producing complicated reconfigurable circuits for experiments in quantum optics and linear optical quantum computing. We use a universal multiport interferometer design to achieve full reconfigurability of the device.

The fabricated device performs at a switching time of 10 ms setting a record for tunable femtosecond laser written devices. We present a thorough analysis of reconfigurability using an adaptive tuning strategy and provide an accurate account of the imperfections of reconfigurable devices fabricated with the femtosecond laser writing technology and possible approaches to overcome the reported issues. The device was shown to produce arbitrary intensity distributions on the output with average fidelities exceeding 0.99. We believe that our work provides a new and valuable approach for fabrication of medium-sized active circuits, and will be of interest for the integrated photonics and quantum optical communities.

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