# Optical switching in metal electrodes embedded dual-core optical fibre

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**Abstract**

**Micro-structured optical fibres (MOF) have been designed in a large variety of geometries. Much of these efforts were focused on control of dispersion, enhancement of the nonlinearity, reduction of the fibre transmission loss, or sensitivity to the environment for sensing in single-material MOFs. Multi-material MOFs have also been developed for added functionality, e.g, hollow-core fibres filled with liquid for temperature sensing [1] or with integrated electrodes for switching applications [2].**

Optical fibres whose optical properties can be externally controlled after fabrication could open up a new range of applications. An example of such a reconfigurable fibre is the dual suspended-core optical fibre [3] which consists of two independent cores suspended by thin membranes and surrounded by air. The cores interact with each other via their evanescent optical fields. Changing the core-to-core separation by mechanical or electrical actuation changes the optical coupling length and thus allows for active control of the propagating light. In [3], optical switching was demonstrated by applying pressure. With just 8 nm change in core separation it was possible to observe switching of the light from one core to the other at the fibre output. Other mechanisms to induce optical switching, apart from pressure, can be electrostatic actuation [4], opto-mechanical forces [5] or thermally changing the refractive index of the glass cores. Forms of electrical actuation operating at low voltages/low powers in general benefit from introducing electrodes close to the optically guiding cores, i.e., from inserting metal electrodes into the fibre.

Here we report on the fabrication of dual suspended-core optical fibres with integrated tin electrodes and the optical switching achieved when electric current is applied to the electrodes, increasing the temperature of the cores. The dual suspended-core structure is at the centre of the fibre with four electrodes surrounding it. The dimensions of the cores are 2x3 μm, separated by 200 nm and suspended by two glass membranes of 500 nm thickness. The fibres were fabricated in lead-silicate glass (Schott F2) which exhibits a low softening temperature (592°C) allowing for preform and jacket tube fabrication via glass extrusion with stainless steel dies. In 50 cm of fibre we observed optical switching between cores by applying 0.4 W of electrical power. This kind of design opens up new possibilities for applications of optical fibres as micro/nano-electromechanical systems (M/NEMS) where light is not only transmitted passively through the fibre but the optical transmission properties can be actively controlled. These two characteristics will allow for the development of all-fibre NEMS devices avoiding the use of chip-based micro-mirrors and micro-lenses.

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