Semiconductor core fibres: A new platform for nonlinear optics?

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The nascent field of semiconductor core fibres is attracting increasing interest as a means to exploit the optoelectronic functionality of the semiconductor materials directly within the fibre geometry [1]. Compared to their planar counterparts, this new class of waveguide retains many of the advantageous properties of the fibre platforms such as robustness, flexibility, cylindrical symmetry, and long waveguide lengths (Fig. 1a). Furthermore, by making use of the complex microstructured optical fibres as templates (Fig. 1b), or by employing standard fibre post-processing procedures such as tapering (Fig. 1c), it is also possible to tailor the waveguide design far beyond what is achievable on-chip, of particular use for nonlinear applications [2]. In this paper I will review our efforts regarding the optical characterization of semiconductor fibres fabricated via a high pressure chemical deposition technique. Results of transmission measurements obtained for fibres with different core materials and geometries will be presented, with the potential to extend the application of these fibres into the long (mid to far-infrared) wavelength regimes being discussed. More recently, the high Kerr nonlinear coefficient and relatively low optical losses of the hydrogenated amorphous silicon (a-Si:H) core fibres have allowed for the first nonlinear characterizations of the semiconductor core fibres [3]. These measurements will be presented together with preliminary demonstrations of nonlinear device functionality (e.g., all-optical switching and modulation), from which we can benchmark the performance of the silicon fibres [4]. Although many of the first generation semiconductor fibres have been fabricated with relatively large core sizes, several microns in diameter [2] or larger [1], by scaling the core size down towards the nanoscale dimensions used on-chip the nonlinear effects will be enhanced and the free carrier recovery time reduced, paving the way to low power, high speed devices. An extreme example of this is our microcylindrical silicon fibre-based resonators (inset Fig. 1c) that have been used to demonstrate picosecond switching at micro-watt power levels [5].

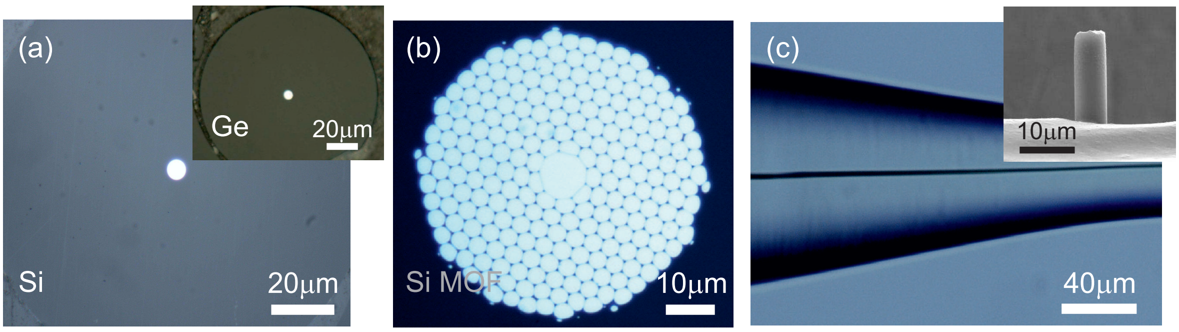

Fig. 1. (a) Step-index silicon core fibre (inset: germanium core), (b) silicon microstructured optical fibre, and (c) tapered silicon core fibre (inset: silicon microcylindrical resonator).

References

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