FABRICATION OF WAVELENGTH-FLATTENED TAPERED COUPLERS USING POLISHING FOR CLADDING REMOVAL

Indexing terms: Optical fibres, Optical transmission, Optical connectors & couplers

Wavelength-flattened fused tapered couplers have been fabricated with low loss using a new technique. The asymmetry between the constituent fibres is induced by the rapid removal of a small amount of the cladding of one of the fibres with a polishing wheel.

Introduction: The production of a wavelength-flattened response in fused tapered couplers by inducing an asymmetry into the coupling fibres is by now well established and well understood. Such couplers can be made by pre-tapering[1] or by pre-etching[2] one fibre prior to coupler fabrication, or indeed by using two dissimilar fibres.[3] The different cladding diameters of the coupling fibres induced by these techniques has a big influence on the performance of the resulting coupler. This is because in the single-mode fibre taper the fibre core plays little part in the light guidance, so that the cladding and external medium form the guiding structure.

With the above techniques, the asymmetry within the coupler is due only to the different cladding diameters of the constituent fibres, with the fibres retaining circular symmetry. In this letter it is shown that the asymmetry can also be introduced by removing a small amount of cladding from one fibre by side-polishing it prior to coupler fabrication.

Side-polishing of the fibre: Polishing is achieved by suspending the stripped fibre under slight tension over a 7 cm diameter diamond grit polishing wheel for 20–30 seconds.[4] The roughness of the polished surface does not pose too much of a problem in this application, since the fibre is automatically fire-polished during the fusing and tapering stage of coupler fabrication.

Coupler characteristics: Two couplers were fabricated from the same single-mode fibre (cladding diameter = 95 μm, cutoff wavelength = 700 nm) using the usual procedure, except that for one coupler one fibre was polished in the manner described above. Each coupler's wavelength response was measured, and in both cases the loss was found to be 0·3 dB. Fig. 1*a* shows the wavelength responses for both couplers after they had been tapered through one coupling cycle at a wavelength of 1000 nm, and Fig. 1*b* shows the wavelength responses after the couplers had been further tapered through their second coupling cycle at 1000 nm. In each case the symmetric coupler's responses exhibit the usual total power transfer characteristic, while the asymmetric coupler's responses display a wavelength-flattened characteristic typical of such couplers.[1] For the asymmetric coupler the level of asymmetry is 'large' since only a small fraction of the power is ever coupled to the second fibre.

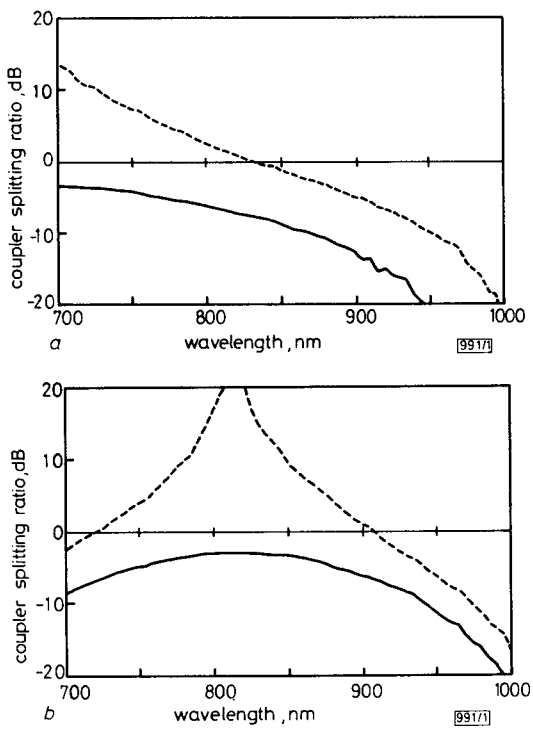

Fig. 1 *Spectral power-splitting ratio of symmetric (broken line) and asymmetric (solid line) couplers*

a Tapered through one coupling cycle at wavelength of 1000 nm
b Tapered through two coupling cycles at wavelength of 1000 nm

This coupler was then cleaved at its taper waist and the cross-section examined under a microscope. Fig. 2 is a photograph of this coupler's waist region, where the polished flat is clearly visible and is slightly rounded off at the edges.

Discussion: The removal of a small amount of cladding is seen to have a large influence on the extent of coupling. This is in accord with previous results on the sensitivity of asymmetric couplers to the difference in cladding diameters.[2] Good control is therefore required over the polishing procedure in producing a reproducible result. However, if the amount of cladding which is removed is reproducible from fibre to fibre, then the maximum coupled power can be adjusted by controlling the degree of fusion of the tapered fibres in the coupler.[5] It is notable that the asymmetric coupler displayed similar loss to the symmetric coupler despite the noncircularity of the side-polished fibre.

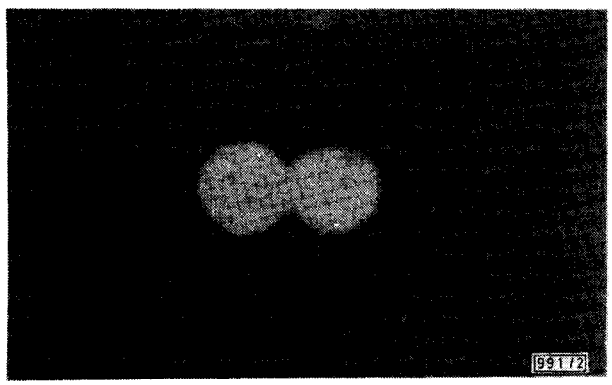

Fig. 2 *Cross-section of asymmetric coupler showing polished flat*

Conclusion: We have demonstrated that a wavelength-flat fused tapered coupler can be produced from asymmetric fibres where the asymmetry is produced by polishing one fibre slightly before coupler fabrication.

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