Short Wavelength Generation using Sub-Micrometre Diameter Optical Fibres

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Light generation at short wavelengths, particularly in the UV spectral range, has numerous potential applications, such as biomedical, lithography and undersea communications [1-3]. To date, this has been achieved using excimer lasers like KrF or XeCl, expensive diodes or near-IR lasers with nonlinear crystals, which suffer from poor beam shapes, relatively complicated optics and relatively low power. Recently, intermodal third harmonic generation in sub-wavelength optical fibres has been proposed to generate light at short wavelengths from near IR laser sources [4]. However, conversion efficiencies have been limited to 10^{-3} [5] because of the intrinsic surface waves frozen in all amorphous materials during the glass-making process. Here, light at short wavelengths have been generated in optical fibres using the intermodal four wave mixing (FWM) in tapered optical fibres with sub-micrometer diameter.

FWM in tapered fibres exploits the tailorable waveguide dispersion to compensate for the material dispersion and achieve phase matching. Remarkably, in FWM phase matching has a relatively loose dependence on the diameter and allows circumventing the limitations caused by surface waves to the third harmonic generation. Simulations carried out with a pulsed source at λ=1.55μm, a second harmonic at λ=0.775μm generated by a periodically poled fibre and a third harmonic at λ=0.517μm resulting from the parametric amplification was used to generate light at λ~0.39μm and λ~0.31μm from all fiberised FWM process. Experiments confirmed that at the phase matching diameters light can be generated at λ~0.39μm and λ~0.31μm.

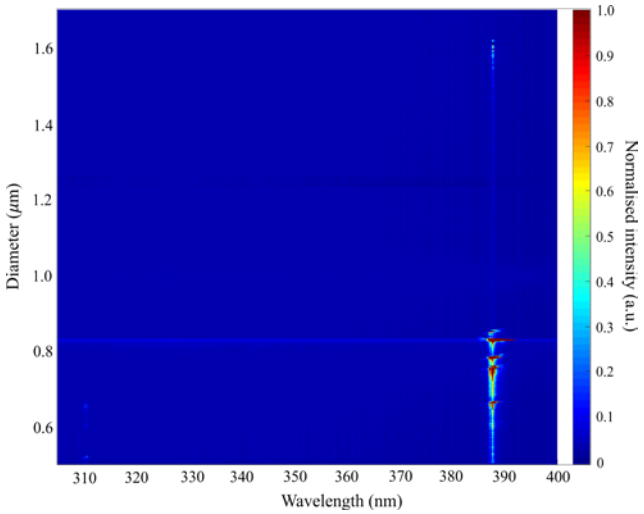

Figure 1. Intensity at the fibre output for different fibre taper diameters. Intensity is maximised at the phase matching diameters (~0.67μm, ~0.78μm, ~0.83μm)

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