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**Title:** Enhanced performance of an S-band fiber laser using a thulium-doped photonic crystal fiber

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**Abstract:** This work proposes a new method to enhance the performance of an S-band fiber laser by using a thulium-doped photonic crystal fiber (PCF). The proposed method is based on amplified spontaneous emission (ASE) suppression provided by the thulium-doped PCF unique geometric structure. The enhanced performance of this filter based PCF is dependent on the short and long cut-off wavelength characteristics that define the fiber transmission window. Realizing the short wavelength cut-off location requires the PCF cladding to be doped with a high index material, which provides a refractive index difference between the core and cladding region. Achieving the long cut-off wavelength necessitates enlarging the size of the air holes surrounding the rare-earth doped core region. The PCF structure is optimized so as to achieve the desired ASE suppression regions of below 0.8 mu m and above 1.8 mu m. The laser performance is simulated for different host media, namely pure silica, alumino-silicate, and fluoride-based fiber ZBLAN based on this thulium-doped PCF design. The host media spectroscopic details, including lifetime variations and quantum efficiency effect on the lasing emission are also discussed. Information on the filter based PCF design is gathered via a full-vectorial finite element method analysis and specifically a numerical modelling solution for the energy level rate equation using the Runge-Kutta method. Results are analyzed for gain improvement, lasing cavity, laser efficiency and effect of core size diameter variation. Results are compared with conventional thulium-doped fiber and thulium-doped PCF for every single host media. We observe that the ZBLAN host media is the most promising candidate due to its greater quantum efficiency.

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