# High Performance Large-Mode Area Double-Clad Fibers for kW Power Scaling of Fiber Lasers from 1 to 2.1 µm

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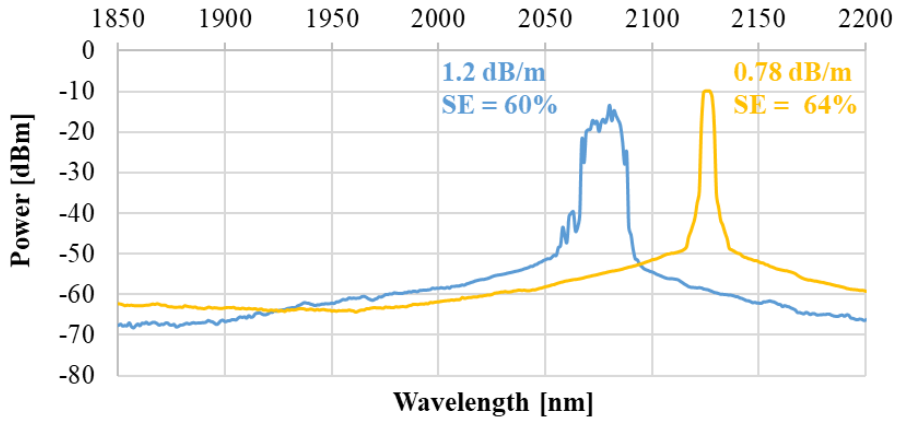
**Abstract:** Advances in Yb-doped and Tm-doped Double-clad LMA fibers to power-scale fiber lasers beyond multi-kW are presented, demonstrating > 3 kW at 1µm and > 65% slope efficiency at 2 µm.

Power scaling 1µm commercial fiber lasers beyond 2 kW output power requires tailored Large-Mode Area Yb-doped double-clad fibers (LMA-YDF) designed to effectively and consistently mitigate non-linear effects such as Stimulated Raman Scattering (SRS) and Transverse mode instability (TMI). An empirical model was developed to design LMA-YDF's capable of delivering > 3 kW output power. The manufactured LMA-YDF's were demonstrated to consistently meet this power target when deployed in simple and cost-effective single-oscillator cavities while ensuring minimal output power degradation through reduction of photodarkening in the glass.

On the other hand, fiber lasers emitting in the 2 µm wavelength regime suffer stringent thermal load constraints from the unfavourable quantum defect compared to their Yb-doped fiber counterparts which limits the achievable output power. Increasing the Tm-doping concentration was demonstrated to promote the two-for-one photon process resulting in more than 70% slope efficiency from a single-mode Tm-doped double-clad fiber (SM-TDF), ~ 20% higher than traditional SM-TDF [1]. To enable power scaling of 2 µm fiber lasers beyond the kW regime, novel high concentration LMA-TDF's have been designed. The new fibers were manufactured using MCVD solution-doping and were tested in low-power Fresnel oscillator. Results illustrated below demonstrate the fiber capability of achieving ~ 65% slope efficiency between 2.04 and 2.1 µm, which is ~15 to 20% higher than conventional LMA-TDF's.




[1] R. Tumminelli et al., Proc. SPIE 10512, Fiber Lasers XV: Technology and Systems, 105120M (14 March 2018); https://doi.org/10.1117/12.2295936

Biography: Clemence Jollivet received her PhD in Optics from the University of Central Florida. In 2014 she joined the R&D department of Nufern and since 2017 she is leading the R&D department of the Specialty Fiber and Assemblies business of Coherent Corp. Her technical expertise includes optical fiber designs, materials, devices and components for applications in fiber laser systems and sensors.

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