Kilowatt fiber lasers and beyond

David N. Payne

Optoelectronics Research Centre
University of Southampton
Southampton SO17 1BJ, United Kingdom

Born out of the telecom revolution, the supreme attributes of rare-earth doped fibers has allowed Yb-doped fiber lasers to be power-scaled from 0.1 to several kW's in only a few years. Remarkably, we still see fiber lasers being limited by the diodes rather than the fibers themselves, even as output powers have continued to rise well into the multi-kW regime. Despite these impressive results, high-power fiber laser development is still in its infancy with a high rate of progress. Limited investment rather than the fundamentals of the technology is the biggest hurdle to the 10 kW-level from a single-emitter diffraction-limited fiber source. Looking to the future, fiber sources are also extremely attractive for beam combining for power-scaling to perhaps 100's of kW. Of particular interest here is the astounding single-frequency powers that have been obtained, also now approaching 1 kW.

Numerous fiber laser pulse schemes are also available, giving pulses from the femtosecond to the microsecond regime with peak power (compressed) in the multi MW's . With large core designs, pulse energies up to 0.1 J can be obtained. Wavelengths from 800 nm to 2100 nm and beyond are seamlessly available through appropriate choice of rare-earth dopant or through Raman shifting. Moreover, these characteristics can be realized with exceptional control of the output stability and beam profile. The key to this is the ability of fibers to combine high power and high efficiency with high broadband gain and excellent beam quality in sophisticated master oscillator – power amplifier configurations.

This presentation will discuss progress and prospects for high-power fiber sources, treating "simple" power-scaling as well as more sophisticated single-frequency and pulsed sources at different wavelengths. Adding the attributes of small size, maintenance-free operation, and high thermal and electrical efficiency, we see that fiber lasers have the potential to change every industry and discipline they encounter and challenge currently held views on how to make things, how to repair things, and how to destroy things.