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Dielectric waveguide lasers: The realm of efficiency

Rare-earth ions have been widely exploited for amplification and lasing on various electronic transitions from the near-ultraviolet to the mid-infrared spectral region. The small transition cross sections of rare-earth ions result in a large absorption length of pump light, thus dictating an accordingly long interaction length with the active material to exploit the delivered pump power. In the past two decades, waveguide geometries that rely on the total internal reflection of pump and signal light on their propagation through the active material have become very successful. These geometries allow for tight pump- and signal-light confinement, hence high optical pump intensities and excellent overlap between pump and signal beam over very long interaction lengths, thereby ensuring good pump absorption and enabling a low threshold and high efficiency. The excellent performance of these devices is based on careful analysis and exploitation of the specific spectroscopic properties of the utilized rare-earth ion. Recent examples include a Tm-doped potassium double tungstate channel waveguide laser with an active ion concentration of 8%, thus ensuring efficient cross relaxation of 800-nm-pump excitation and resulting in record-high slope efficiency for any Tm-doped laser of ~80%. Furthermore, distributed-feedback and distributed-Bragg-reflector narrow-linewidth channel waveguide lasers were demonstrated in Er- and Yb-doped amorphous aluminum oxide on a silicon wafer by inscribing a uniform Bragg grating into the silicon oxide top cladding, with laser linewidths down to 1.7 kHz and slope efficiencies up to 67%.

Biography

Markus Pollnau received MSc and PhD degrees in Physics from University of Hamburg, Germany (1992) and University of Bern, Switzerland (1996), respectively. In 2004, he became a Full Professor at the University of Twente, The Netherlands and moved to KTH, Sweden, in 2014. He has contributed to more than 500 reviewed journals and international conference papers on crystal and thin-film growth, rare-earth-doped lasers and waveguide fabrication, devices and applications. He served as General Co-chair of the Conferences on Lasers and Electro-Optics (2008), Lasers and Electro-Optics Europe (2011) and the Europhoton Conference (2004). He is a fellow of OSA and EPS.

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