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Design of direct diode pumped amplification stages based on Tm ceramics for kHz rep-rate, kW average power lasers: Design issues and material characterization

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Scaling current ultrashort/ultraintense laser technology, based on Nd-pumped TiSa amplifiers, to the rep-rate and average power required for future laser-driven electron accelerators is ultimately hindered by wall plug efficiency. One of the paths currently pursued to overcome the limits of TiSa technology is based on the usage of long ($\sim$ ms) upper state lifetime materials that can be directly pumped using (quasi-)CW diode pumping. Energy is extracted over multiple laser pulses, in what is called a *Multi-Pulse Extraction (MPE)* scheme, at a rep rate higher than the inverse of the active material lifetime. Thulium doped hosts are among these materials, while at the same time featuring large bandwidths, and thus allow amplification of ultrashort pulses, dramatically increasing, at the same time, wall-plug efficiency.
Here we report on the design and development of a kW-class average power, J-level laser system, featuring amplification stages based on Tm-doped sesquioxides ceramics in an active mirror configuration. After a quick look at the overall system design, we will focus, in particular, on issues related to the diode pump characterization and pumping geometry optimization, as well as on the experimental characterization of the Tm ceramics affecting the MPE dynamics.

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