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Mid-infrared lasers based on transition metal doped II-VI semiconductors

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Recent progress in fabrication of high-quality thermo-diffusion doped polycrystalline and hot-pressed ceramic Cr²⁺ and Fe²⁺ doped ZnSe and ZnS gain media as well as crystal field engineering of ternary and quaternary compounds enabling amplification bandwidth extension up to 8 μm are reported. We also report on the spectroscopic study of Cr²⁺:ZnSe/ZnS under visible excitation into the charge transfer band of Cr²⁺ ions. Cr:ZnSe lasing at 2.5 μm induced by $2+ \rightarrow 1+ \rightarrow 2+$ ionization transitions of chromium under visible excitation was achieved. A spectroscopic characterization of cobalt and iron-cobalt co-doped ZnS and ZnSe crystals over 14-300K temperature range was performed. Mid-IR laser oscillation at 3.9 μm (3.6 μm) via energy transfer in the Co:Fe:ZnSe (Co:Fe:ZnS) co-doped crystals was demonstrated under cobalt excitation at $4A_2(F) \rightarrow 4T_1(P)$ ($\sim 0.7 \mu\text{m}$) and $4A_2(F) \rightarrow 4T_1(F)$ ($\sim 1.56 \mu\text{m}$) transitions. Progress in the technology of fabrication of high-quality uniformly doped transition metal (TM) doped ZnSe/S gain elements in combination with proper thermal management and cavities design enabled demonstration of high power; high energy; tunable (1.9-3.3 μm), mid-IR Cr:ZnS/Se lasers operating in CW ($>25 \text{ W}$), gain-switched ($>20 \text{ mJ}$ at 7ns), mode-locked ($>1 \text{ W}$ at 65fs at 90 MHz), and long pulse ($>1 \text{ J}$ at 7ms) regimes. We will also report on recent progress in development of new gain media for tunable (3-8 μm) mid-IR lasers as well as Fe:ZnS/Se lasers operating in CW ($>1.5 \text{ W}$), gain-switched ($>1 \text{ mJ}$ at 7ns at 1kHz) and long-pulse ($>0.5 \text{ J}$ at 200 μs) regimes. TM doped II-VI media, being wide band semiconductors, hold potential for direct electrical excitation. Possible promising routes for achieving mid-IR lasing under electrical excitation will be discussed.

Biography

Sergey Mirov received PhD in Physics in 1983 from the P. N Lebedev Physics Institute of the USSR Academy of Sciences. Since 1993, he is a Faculty at the University of Alabama at Birmingham. Currently, he is a university Professor of Physics at the UAB and Director of the Center for Optical Sensors and Spectroscopies. He is a Fellow of the Optical Society of America, and member of the American Physics Society, and SPIE. He has authored or co-authored over four hundred scientific publications, has published 1 book, several book chapters, and holds twenty patents.

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