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CELOÚSTAVNÍ SEMINÁŘ
FZU COLLOQUIUM

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Přednáškový sál SOLID21 | Lecture hall SOLID21
Na Slovance 1999/2, Praha 8

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Novel Optical Materials as Solid-State Light Emitters and Laser Media

Light sources in the ultraviolet (UV, λ = 400 nm to 250 nm), deep ultraviolet (DUV, λ = 250 nm to 190 nm) and vacuum ultraviolet (VUV, λ = 190 nm to 100 nm) wavelength regions have numerous technologically important applications, including lithography, sterilization, and surface modification. Solid-state lasers in these short wavelength regions offer the promise of being more robust, easier to maintain, and more cost-efficient light sources compared to conventional excimer lasers, synchrotron radiation, and free electron lasers (FEL). Towards UV, DUV and VUV laser development, we have explored fluoride crystals such as lithium calcium aluminum fluoride (LiCaAlF) and lanthanum fluoride (LaF) as excellent solid-state laser host materials because of their extremely wide band gaps which make them transparent down to about 100 nm. Fluoride crystals have been successfully doped with trivalent rare-earth ions such as cerium (Ce^{3+}) and neodymium (Nd^{3+}), whose dipole-allowed interconfigurational 5d to 4f transitions result in broad fluorescence bandwidths that enable the development of short-pulse tunable solid-state UV lasers. Interconfigurational transitions also result in fast luminescence emission. We leverage these fast emissions to develop fast-response scintillators that detect high-energy radiation. In addition to rare-earth ion doped fluorides, we also explored zinc oxide (ZnO) as a fast-response scintillator for the detection of extreme ultraviolet (EUV, λ = 10 nm to 100 nm) radiation. Undoped ZnO exhibits fast, nanosecond UV luminescence at room temperature. By intentional doping with impurities such as iron and indium, the luminescence decay time of ZnO increases by over two orders of magnitude, bringing its luminescence decay time in the picosecond range. Using indium-doped ZnO, we have demonstrated the synchronization of EUV-FEL and femtosecond Ti:sapphire laser pulses with about 3-picosecond accuracy. In this talk, I will present our work on rare-earth ion-doped fluoride crystals for solid-state UV, DUV and VUV laser and scintillator development and our work on undoped and impurity-doped ZnO scintillators.