Laser Research Center for Molecular Science

IX-W Developments and Researches of New Laser Materials

Although development of lasers is remarkable, there are no lasers which lase in ultraviolet and far infrared regions. However, it is expected that these kinds of lasers break out a great revolution in not only the molecular science but also in the industrial world.

In this project we research characters of new materials for ultraviolet and far infrared lasers, and develop new lasers by using these laser materials.

IX-W-1 Growth and Scintillation Properties of Yb Doped Aluminate, Vanadate and Silicate Single Crystals

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[*Opt. Mater.* **26**, 529 (2004)]

For the purpose of quick screening for charge transfer (CT) transitions of Yb_3 in various hosts, $(Lu_{1-x}Yb_x)_3Al_5O_{12}$ (Yb:LuAG) with x = 0.05, 0.15, 0.30 and $(Y_{1-x}Yb_x)AlO_3$ (Yb:YAP) with x = 0.05, 0.10, 0.30 were grown by the micro-pulling-down method. $(Y,Yb)VO_4$ with strong wetting was grown by edge defined film-fed growth method and materials, which require moderate temperature gradient, such as $Ca_8(La,Yb)_2(PO_4)_6O_2$ and $(Gd,Yb)_2SiO_5$ were grown by Czochralski method. Strong dependence of the CT luminescence decay time and intensity on temperature was observed for Yb-doped LuAG and YAP. Super fast decay with 0.85 ns decay time was observed in Yb(30%) doped YAP at room temperature. Though the emission intensity is weak at room temperature, it exceeds several times that of $PbWO_4$. In addition, CT luminescence of Yb:YAP occurs at longer wavelength than in BaF_2, which enables the usage of glass-based photomultiplier for the detection. In addition, higher stopping power will be expected due to the higher density host compared with BaF_2.

IX-W-2 Onset Detection of Solid-State Phase Transition in Estrogen-Like Chemical *via* Terahertz Transmission Spectroscopy

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[*Appl. Phys. Lett.* **85**, 3914 (2004)]

Solid-state phase transition onset in an endocrine-disrupting estrogen-like chemical (1,4-naphthol) is detected using terahertz transmission spectroscopy. The appearance of two absorption peaks and the sudden upsurge of terahertz-radiation power at 210 K indicate the onset of the solid-state phase transition. Differential scanning microscopy reveals a first-order phase transition at around 240 K while temperature-dependent x-ray diffraction analysis shows the occurrence of such phenomenon also at around 240 K. This demonstrates the sensitivity of the terahertz spectroscopic technique to phase transition since it provides a signal before such phenomenon actually occurs.

IX-W-3 Design Principle of Wide-Gap Fluoride Hetero-Structures for Deep Ultraviolet Optical Devices

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[*J. Appl. Phys.* **96**, 7655 (2004)]

The design of fluoride-based optical devices for deep ultraviolet applications is discussed. Variations in the band-gap energy and band structure with respect to composition are investigated for $Li_{(1-x)}K_xBa_{(1-y)}Mg_yF_3$ perovskites. The band-gap energy, lattice constant, and band structure of perovskitelike fluorides are estimated based on *ab initio* calculations within the local-density approximation. The lattice-matched double heterostructure with direct band-gap compounds $(Li_{(1-x)}K_xBa_{(1-y)}Mg_yF_3$ on either $LiBaF_3$ or $KMgF_3$ substrates) is promising for fabrication.

IX-W-4 Terahertz Time-Domain Spectroscopy of Amino Acids and Polypeptides

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[*Biophys. J.* L22 (2005)]

Frequency-dependent absorption coefficients and refractive indices of amino acids (glycine and L-alanine) and polypeptides (polyglycine and poly-L-alanine) in the wavenumber region from 7 to 55 cm^{-1}

were measured by terahertz timedomain spectroscopy. A vibrational band was observed at 45.5 cm^{-1} for polyglycine, which was assigned as an interchain mode. The reduced absorption cross sections of the amino acids and polypeptides show power-law behavior. The exponents are different between the monomers and polymers, and those of the two polypeptides suggest that the time dependences of the total dipole moments are similar in the timescale of subpico- to picoseconds.