Center for Molecular Spectroscopy and Dynamics, IBS-Korea University

IBS Center for Molecular Spectroscopy and Dynamics

Seminar

- **SPEAKER**
  Dr. Ashwini Kumar Rawat (IBS CMSD)

- **TITLE**
  Application of high-repetition-rate femtosecond laser-induced photo-thermal spectroscopy for probing molecular interactions and properties

- **ABSTRACT**
  Thermal lens (TL) spectroscopy is based on the photo-thermal effect, where the energy of a photon is converted, fully or partially, into heat energy. In this spectroscopy, a laser source is chosen in such a way that its wavelength can couple with the electronic or vibrational states of the sample under study. TL is a result of the temperature gradient that directly changes the refractive index and thereby generates a refractive index gradient in the sample, which finally behaves as a lens that we call the thermal lens. This is a highly sensitive and non-destructive analytical technique. This thesis is primarily concerned with probe intermolecular interactions and their properties, which are induced by high repetition rate (HRR) femtosecond laser-induced photo-thermal lens spectroscopy. Basically, research work is divided into two sections, like sections one and two. In the first section, one project was done using a single-beam laser experimental setup, and in the second section, four projects were done using a dual-beam (pump-probe) laser experimental setup. This talk starts with an idea of the motive for the current work and then focuses on the instrumentation and theory involved in all the experiments and, lastly, the research projects.

  Project 1 In this close aperture Z-scan (CAZS) technique used for the measurement of third-order optical thermal nonlinearity, specifically the index of nonlinear refraction value, based on this application, we successfully distinguish monosaccharide isomers. Project 2 demonstrates how such thermo-optic properties vary with laser power in monohydric, dihydric, and trihydric alcohols. Project 3 focuses on the novel spectroscopic distinction possible for monohydric alcohols with femtosecond laser-induced thermal lens spectroscopy. This new approach to distinguishing alcohols and their impacts on understanding intermolecular interactions in liquids would be of high interest. The TL measurements successfully distinguished the monohydric (aliphatic, cyclic, and aromatic) alcohols from their homologous series with a similar number of carbon atoms belonging to different homologous series. Project 4 We investigate the effect of pH on the thermophysical properties of monohydric and polyhydric alcohols using thermal lens (TL) spectroscopy. Here, monohydric alcohols (MeOH and EtOH), longer chain length or larger structure monohydric alcohols (HxOH and phenol), and polyhydroxy alcohols (Ethylene Glycol and Glycerol) are discussed. For the first time, this study demonstrates the importance of molecular properties and ion-solvent interactions in the thermophysical properties of alcohols. Project 5 This is non-contact localized laser heating-based thermal lensing, which has emerged as a technique for probing the heat transport in liquids. The purpose of this technique is to investigate the photo-thermal response and heat transfer in methanol and binary mixtures of methanol with polar (water, DMSO) and nonpolar (CCl_4) solvents. Most significantly, additional experiments have been proposed considering the current findings and discussions in this thesis. The work presented in this thesis aims to expand the scope of this TL application to a new level.

- **DATE AND VENUE**
  October 27, 2022 (Thursday, 11:00 - 12:00)
  Seminar Room A (116)

- **LANGUAGE**
  English