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Themed Collection

Versatility of Raman Spectroscopy as an Analytical Tool for Chemists

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Often used as a tool in analytical chemistry, Raman spectroscopy is a highly utilized non-destructive vibrational spectroscopic technique. Incident light interacts with the molecules, and the inelastically scattered light is analyzed in Raman spectroscopy. The energy of the scattered photons is shifted due to the vibrational transitions in the molecule. Vibrational modes involve the periodic motion of atoms within a molecule, such as the stretching and bending of chemical bonds. In Raman spectroscopy, a vibrational mode is Raman-active if it induces a change in polarizability. Various scientific disciplines benefit from the rich information provided by Raman spectroscopy about the molecular composition and structure of compounds. Raman spectroscopy is extensively used by analytical chemists for molecular identification, structural analysis, and reaction monitoring. In particular, Raman spectroscopy offers high sensitivity and specificity in the analysis of pharmaceutical compounds, including drug formulations, polymorphs, and the study of drug interactions with biomolecules. Raman offers many advantages in the characterization of materials, including polymers, ceramics, semiconductors, and nanomaterials. Raman spectroscopy is applicable to solids, liquids and gasses and is applicable for pollutant analysis, air quality monitoring and water quality testing. Raman is a versatile tool for studying vibrational and electronic transitions in materials and it provides insights into lattice dynamics, phonons, and other physical properties. Biologists use Raman spectroscopy for cellular and tissue analysis, drug detection, and studying biomolecular structures. Due to off-the-shelf electronics and the high computational capability of embedded systems, the technique can be now packaged into a compact portable spectrometer. Applications requiring high throughput, rapid, and in-situ testing benefit from portable Raman techniques. Food quality testing and authentication, forensic analysis (for the identification and characterization of substances, including drugs and forensic evidence) and archaeometry (identification of pigments, dyes, and materials in artworks and cultural artifacts) are some fields that benefit from portable Raman spectrometry. With the onset of embedded AI technologies, machine learning is expected to transform Raman Chemometrics (chemometrics involves the use of mathematical and statistical methods to extract meaningful information from complex chemical data). We are about to enter into a new regime of Analytical Chemistry related to spectroscopy, where machine learning algorithms provide insights on the underlying chemistry and structure of compounds via multidimensional data provided by Raman spectra.

Recently, a new optical research facility equipped with a research-grade Raman spectrophotometer was established at the Faculty of Science, University of Colombo. Funding for the facility was provided under the grant scheme, Accelerating Higher Education Expansion and Development (AHEAD)-Development of Research (DOR) which is a World Bank funded Sri Lankan government operation to support higher education. As a result of the initiative, a multidisciplinary research group, ALOKA (Artificial intelligence and Light assisted Opto-electrochemical-Kinematic Agents) was formed to expand collaborative research in Analytical Chemistry, Materials Physics, Mechatronics and Data Analytics. Developing cost-effective Raman spectroscopy instrumentation combined with machine learning remains a high priority for the group and anticipates wider opportunities to integrate with the industry. Developing new materials for surface enhanced Raman spectroscopy to probe diseases, test food quality and detect environmental pollutants is currently undertaken. For more information, please visit the group webpage at https://aloka.cmb.ac.lk/. For establishing research collaborations, please contact the Director, Center for Instrument Development via email at aloka@sci.cmb.ac.lk.

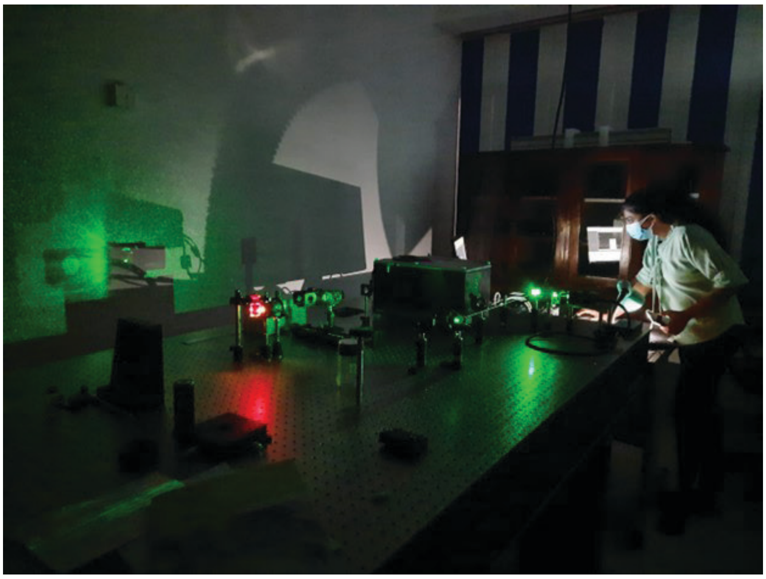

Figure: The Center for Instrument Development Laboratory at the Department of Physics in the Faculty of Science of the University of Colombo now houses a Research grade Raman Spectroscopy setup. The image shows a graduate student initializing Raman spectroscopy. The facility is now open for research collaborators and industrial partners to build partnerships with affiliated researchers at the ALOKA group, Center for Instrument Development. For more information, please visit the group webpage at https://aloka.cmb.ac.lk/

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Nanomatrix Structures Prepared on Natural Rubber Particles in Latex Stage

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Nanomatrix structures are prominent filler network structure which usually improves the mechanical properties of natural rubber or sometimes used to introduce novel properties. The nanomatrix structures have been prepared using both inorganic and organic nanoparticles, such as silica, nanodiamond, and polystyrene, methyl methacrylate, Polyaniline respectively. The nanomatrix structure is a phase separated structure, where, natural rubber particles are dispersed as a major component into matrix of nano-composite with inorganic or organic nanoparticles as a minor component. Mechanical properties of the polymers, which are related to the nanomatrix structure, may be tunable with size, surface area, interaction and dispersion of the inorganic nanoparticles in the matrix.

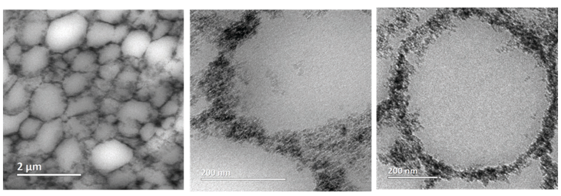

Figure 1. TEM images of Nanodiamond Nanomatrix Structure Prepared onto natural rubber Particles at