INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

Name of the Student	:	**SUJAY PAUL**
Roll Number	:	**186122105**
Programme of Study	:	**Ph.D.**

Thesis Title: **Raman Spectroscopy of Nanoparticle-laden Evaporating Sessile Droplets**

Name of Thesis Supervisor(s)	:	**Prof. Arun Chattopadhyay**
Thesis Submitted to the Academic Division	:	**Chemistry**
Date of completion of Thesis Viva-Voce Exam	:	**30/07/2025**
Key words for description of Thesis Work	:	**Plasmonic nanoparticles, SERS, Coffee-ring, 2D crystal**

SHORT ABSTRACT

Evaporation of a sessile droplet having dispersed particles on solid surface is technologically significant mainly due to the various kinds of pattern formation upon complete evaporation of solvent. The major outcome of substantial development in nanoscience and nanotechnology is the supremacy of nanoparticles in various kinds of applications in chemistry, biology, electronics and devices. The understanding of deposition mechanism of nanoparticles is crucial for the newer technology. In the present thesis, the ability of plasmonic nanoparticles to enhance the Raman signature has been utilized to unravel the overall deposition process of nanoparticles from evaporating sessile droplets, which is otherwise not possible easily by other spectroscopic techniques. The present thesis is primarily focused on the mechanistic insight of the deposition process of metal nanoparticles (Au and Ag) forming 'coffee-ring' and chemical reactions on the surface of nanoparticles during the course of evaporation of solvent from sessile droplet containing the particles. This has further pursued for molecular systems leading to the generation of 2D crystals. The thesis is divided into six chapters. **Chapter 1** of the thesis comprises of a brief literature review on plasmonic nanoparticles, surface-enhanced Raman spectroscopy (SERS) and evaporation induced particle deposition, primarily on the novel 'coffee-ring' effect. **Chapter 2** of the thesis comprises of the deposition kinetics of dispersed nanoparticles at the three-phase contact line (TPCL) of an evaporating sessile droplet probed by time-dependent SERS. Unlike for the microparticle systems in which particles deposit linearly with time, our studies discovered that after reaching a particular concentration, the deposition of nanoparticles followed phase transition from dispersion to deposit within a short window of time. The critical concentration for phase transition of 25 nm AuNPs dispersion was 13 μM. Increasing the initial particle concentration leads faster phase transition. Moreover, with the increase of particle size, phase transition of nanoparticles at TPCL occurs earlier. **Chapter 3** of the thesis introduces important utilization of newly discovered deposition process for the distinction of intrananoparticle and internanoparticle chemical reactions on the surface of nanoparticles. In **Chapter 4**, the effect of pH on the deposition mechanism of chemically interacting plasmonic nanoparticles has been studied by SERS. At pH 7.0 and 9.4, only one phase transition of nanoparticle deposition has been observed. However, at pH 8.4, multiple steps of phase transitions and reaction steps have been monitored. The **Chapter 5** of the thesis illustrates the two-dimensional (2D) crystallization of methyl orange and methylene blue molecules at the TPCL of evaporating droplet and surface and interior of 2D and 3D crystals are different in molecular level as studied by Raman measurements. Finally, **Chapter 6** includes the essential conclusions and future prospects of the research works mentioned in the thesis.