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## PREFACE

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Surface enhanced Raman spectroscopy (SERS) with the development of nanomaterials is being used extensively in both pure and applied research, and the number of original articles devoted to this field of spectroscopy is increasing. Instead of noble metals, non-noble or semiconducting materials have gained much attention due to their stability and biological compatibility. Although various non-noble materials have been used in SERS with desirable merits, advancing a new method to perform quantitative analysis of probe molecules on non-noble substrates directly is still challenging. Therefore, further advancements in semiconductor substrates' enhancement capacity are necessary in this area. On the other hand, innovative SERS-active semiconductor substrates need to be developed to satisfy the demands of a specific application. In this regard, this thesis work is subjected to preparing various bismuth-based novel materials as a SERS substrate to attempt the requirement. The summary of all chapters of the thesis is given in the subsequent part that follows.

**Chapter 1** briefly introduces Raman and Surface enhanced Raman spectroscopy and the factors affecting the enhancement of Raman signal. This chapter also describes different types of SERS active substrates, and the concept of the thesis and the methods employed for characterization are present in the last section.

**Chapter 2** discusses the synthesis of bismuth-based novel substrate for surface enhanced Raman spectroscopy. The synthesized materials characterized by

various techniques XRD, SEM, XPS, FTIR, and Raman. The change in phase of the as-prepared materials with change in temperature were analyzed through Raman spectroscopy and used as a SERS substrate. The SERS activity of the synthesized substrates were performed by the detection of standard probe molecules such as methyl orange (MO), rhodamine B (RhB), ascorbic acid (Vit C), and melamine (MEL). In addition, SERS activity of bismuth heterostructure substrate was evaluated for ideal probe p-aminothiophenol (PATP) to study whether it's dimerize or gives genuine SERS spectra because PATP easily transformed into 4,4'-dimercaptobenzene (DMAB), and we observed genuine SERS on bismuth based substrate instead of dimerization.

**Chapter 3** deals with **bismuth oxybromide based novel substrate for surface enhanced Raman spectroscopy**. Bismuth oxybromide ( $\text{Bi}_{24}\text{O}_{31}\text{Br}_{10}$ ) synthesized via the chemical precipitation method and further, the structure and morphology were confirmed through XRD and SEM. XPS and Raman spectroscopy evaluated the chemical state and the phase stability at different temperatures, respectively. The synthesized samples were employed as a SERS substrate for the detection of organic dyes such as methyl orange (MO), rhodamine B (RhB), and p-nitrophenol (4-NP).

**Chapter 4** presents **bismuth oxybromide composites as novel SERS substrate for label-free, non-invasive quantitative detection of detrimental synthetic food colorants**. The composites CTAB-assisted AgBr-bismuth oxybromide were synthesized via the chemical precipitation method, and the product formation was

confirmed through various characterization techniques, XRD, UV-visible spectroscopy, SEM, XPS, and Raman spectroscopy. Rhodamine 6G was used as a proof of principle to show the SERS performance of composite materials. Further, it was utilized for the analysis of food color. Apart from this, the efficiency of silver-containing bismuth oxybromide substrate in real samples was discussed in this section, and a comparative study with the  $\text{Bi}_{24}\text{O}_{31}\text{Br}_{10}$  SERS substrate.

**Chapter 5** reveals **quantitative estimation of isatin and its derivative and acetylcholine neurotransmitter on bismuth based SERS substrate.** The feasibility of SERS activity of bismuth substrate were demonstrated for the detection of biologically important molecules, viz., Isatin and its derivative (1-Misa, 1-Phisa, 5-Fisa, 5-Iisa) on bismuth based substrate. Moreover, pH dependent SERS study of acetylcholine neurotransmitter on bismuth oxide nanoparticles was also discussed.

Finally, this thesis includes the summary of the considered four chapters and a brief discussion of for the future prospective.