

# ***Bismuth-based materials as a novel substrate for surface enhanced Raman spectroscopy***



**THESIS SUBMITTED IN PARTIAL FULFILLMENT  
FOR THE AWARD OF DEGREE**

***DOCTOR OF PHILOSOPHY***

**By**

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*Dedicated to my Parents*

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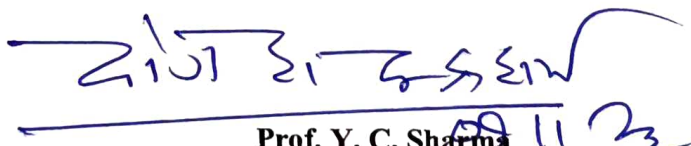
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## Abbreviations

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<b>IUPAC</b>	International Union of Pure and Applied Chemistry
<b>1-Phisa</b>	1-Phenylisatin
<b>1-Ph-AA</b>	1-Phenyl anthranilic acid
<b>1-Misa</b>	1-Methylisatin
<b>4-NP</b>	4-nitrophenol
<b>5-Fisa</b>	5-Fluoroisatin
<b>5-F-AA</b>	5-Fluoro anthranilic acid
<b>5-Iisa</b>	5-Idoisatin
<b>5-I-AA</b>	5-Ido anthranilic acid
<b>AA</b>	Anthranilic acid
<b>Ach</b>	Acetylcholine
<b>AR</b>	Allura red
<b>AM</b>	Amaranth
<b>CTAB</b>	Cetyltriethylammonium bromide
<b>CT</b>	Charge transfer
<b>CM</b>	Chemical enhancement mechanism
<b>DMAB</b>	4, 4'-dimercaptoazobenzene
<b>FT-IR</b>	Fourier Transform Infrared Spectroscopy
<b>EM</b>	Electromagnetic mechanism
<b>EF</b>	Enhancement factor
<b>FWHM</b>	Full width at half-maximum
<b>HOMO</b>	Highest Occupied Molecular Orbital
<b>LUMO</b>	Lowest Unoccupied Molecular Orbital
<b>LSPR</b>	Localized Surface plasmon resonance
<b>MEL</b>	Melamine
<b>MO</b>	Methyl orange
<b>PATP</b>	p-aminothiophenol
<b>RhB</b>	rhodamine B
<b>RSD</b>	Relative standard deviation

<b>R6G</b>	Rhodamine 6G
<b>Ag</b>	Silver
<b>SEM</b>	Scanning electron microscope
<b>SuI</b>	Sudan I
<b>SY</b>	Sunset yellow
<b>SERS</b>	Surface enhanced Raman spectroscopy
<b>SPR</b>	Surface plasmon resonance
$E_{ss}$	surface state energy levels
<b>TR</b>	Tartrazine
<b>Vis</b>	Visible
<b>Vit C</b>	vitamin C
<b>UV</b>	Ultraviolet
<b>XPS</b>	X-ray photoelectron spectroscopy
<b>XRD</b>	X-ray diffraction patterns

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## List of Symbols

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$\omega$	Angular frequency
$\text{\AA}$	Angstrom
<b>a.u.</b>	Arbitrary unit
$\delta$	Bending
$\mu\text{M}$	Concentration
$\epsilon$	Dielectric constant
$\vec{E}$	Electromagnetic field strength
<b>E<sub>q</sub></b>	Energy after the collision
<b>E<sub><math>\beta</math></sub></b>	Energy of the molecule
$\nu_0$	Frequency of incident photon
<b>d</b>	Inter planer spacing
$\vec{E}_0$	Maximum field strength
<b>M</b>	Mass of the molecule
$\Gamma$	out-of-plane bending
$\vec{P}$	Polarization
<b>H</b>	Planck's constant
$\vec{\alpha}$	Polarisability
%	Percentage
<b>P</b>	Rocking
<b>N</b>	Stretching frequency
$^{\circ}\text{C}$	Temperature
$\Theta$	Theta
$\nu_m$	Vibrational frequency
<b>V</b>	Velocity of molecule
$\nu'$	Velocity of the molecule after the collision
<b><math>\Pi</math></b>	Wagging
$\text{cm}^{-1}$	Wavenumber
$\lambda$	Wavelength