

Electrochemical Studies of Some Redox Active Biomolecules and Small Organic Molecules on Nanomaterials Modified Surfaces

by

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Thesis submitted to Jawaharlal Nehru University, New Delhi for the award of the
degree of

Doctor of Philosophy

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Raman Research Institute

Bangalore-560080

CERTIFICATE

This is to certify that the thesis entitled **“Electrochemical Studies of Some Redox Active Biomolecules and Small Organic Molecules on Nanomaterials Modified Surfaces”** submitted by Mr. D. H. Nagaraju, for the award of the degree of DOCTOR OF PHILOSOPHY of Jawaharlal Nehru University, New Delhi, is his original experimental investigation and conclusions. The subject matter of this thesis has not been previously published or submitted to any other university for the award of any other degree or diploma.

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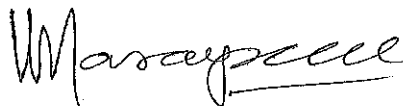
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DECLARATION

I hereby declare that the entire work embodied in this thesis is the result of the experimental investigation carried out by me independently at Raman Research Institute, Bangalore, under the guidance and supervision of Prof. V. Lakshminarayanan. The experimental work and conclusions presented in this thesis work has not been previously submitted and no part of this thesis work has formed the basis for the award of any other degree, diploma, fellowship, associateship or any other similar title.

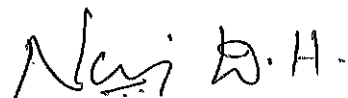


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Publications

1) **D. H. Nagaraju** and V. Lakshminarayanan

Electrochemically grown mesoporous gold film as high surface area material for electro-oxidation of alcohol in alkaline medium.

Journal of Physical Chemistry C 113, **2009**, 14922-14926.

2) **D. H. Nagaraju**, Rakesh K. Pandey, and V. Lakshminarayanan.

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Journal of Electroanalytical Chemistry 627, **2009**, 63-68.

3) **D. H. Nagaraju**, and V. Lakshminarayanan

Electrochemical Synthesis of Thiol-Monolayer-Protected Clusters of Gold.

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4) **D. H. Nagaraju**, and V. Lakshminarayanan

Glucose Biosensor Based on GOx and GOx-Single walled Carbon Nanotubes Immobilized on Self-Assembled Monolayers.

Proceedings Sensors-13, **2008**, C-34-1 to C-34-3

Manuscripts under preparation

5) **D. H. Nagaraju**, and V. Lakshminarayanan

Electrochemically grown mesoporous gold film on pt and graphite substrates for electro-oxidation of methanol and ethanol in alkaline medium.

6) **D. H. Nagaraju**, and V. Lakshminarayanan

Mesoporous Gold Nanoparticles Film for high sensitive detection of glucose

7) **D. H. Nagaraju**, and V. Lakshminarayanan

Electrocatalytic studies on Immobilized proteins and composite protein-Single walled carbon nanotubes on aromatic SAM of 4-Aminothiophenol

8) **D. H. Nagaraju**, V. Lakshman Kumar, and V. Lakshminarayanan

Electrochemical synthesis and *in situ* growth of palladium nanoparticles and its application for methanol, ethanol and formic acid oxidation.

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Abbreviations

CV	Cyclic Voltammetry
EIS	Electrochemical Impedance Spectroscopy
CA	Chronoamperometry
CE	Chronopotentiometry
SWV	Square Wave Voltammetry
SAMs	Self-Assembled Monolayers
STM	Scanning Tunneling Microscopy
AFM	Atomic Force Microscopy
Au	Gold
Au NPs	Gold Nanoparticles
Pt	Platinum
Ag	Silver
Al	Aluminium
SCE	Saturated Calomel Electrode
mV	Milli Volts
mA	Milli Amps
μA	Micro Amps
Q	Constant Phase Element
R_u	Uncompensated Solution Resistance
R_{ct}	Charge Transfer Resistance
C_{dl}	Double Layer Capacitance
W	Warburg Impedance
4-ATP	4-Aminothiophenol
4-MBA	4-Mercaptobenzoic Acid
DT	Decanethiol
MUA	11-Mercaptoundecanoic Acid
Cyt <i>c</i>	Cytochrome <i>c</i>
Myb	Myoglobin
HRP	Horseradish Peroxidase

SWNTs	Single Walled Carbon Nanotubes
MPCs	Monolayer Protected Clusters
Uv-vis	Ultraviolet-Visible
FTIR	Fourier Transform Infrared
SPR	Surface Plasmon Resonance
XRD	X-ray Diffraction
FWHM	Full Width Half Maximum
SEM	Scanning Electron Microscopy
HRTEM	High Resolution Transmission Electron Microscopy
EDAX	Energy Dispersive X-ray
[Fe(CN)]^{4-/3-}	Ferrocyanide/Ferricyanide
[Ru (NH3)]^{2+/3+}	HexamminerutheniumII/III
NaF	Sodium Fluoride
KCl	Potassium Chloride
Na₂HPO₄	Disodium Hydrogen Phosphate
NaH₂PO₄	Sodium Dihydrogen Phosphate
NaBH₄	Sodium Borohydride
H₂O₂	Hydrogen Peroxide
DA	Dopamine
AA	Ascorbic Acid
HER	Hydrogen Evolution Reaction
E_{1/2}	Half Peak Potential
E_a	Activation Energy
v	Scan Rate
Γ	Surface Concentration
Au/Au	Gold on Gold
Au/Pt	Gold on Platinum
Au/C	Gold on Graphite
kJ/mol	Kilo Joules per Mole