

Dr. Srinidhi Raghavan.M

Assistant Professor

Department of Chemistry

BMS College of Engineering

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Present Position

Assistant Professor:(August.2018 – Present)

Department of Chemistry, BMS college of Engineering, Bangalore -19

Visiting Scientist (April. 2018- August 2018)

Centre for Nano science and Engineering (CeNSE), Materials Chemistry Lab, Indian Institute of Science, Bangalore.

Responsibilities: Nanomaterial Synthesis, Semiconductor metal oxide

Development for Energy harvesting devices, Gas sensors and Optoelectronic device optimizations. Water Purification process.

Research Experiences and Education

Postal Doctoral Researcher (Jan.2015 – March-2018)

Centre for Nanoscience and Engineering (CeNSE), Indian Institute of Science, Bangalore. (Supervisor: Prof.Navakanta Bhat)

Theme: Biomarker for Malodorous Gases, solid state semiconductor Gas sensor development for VOC's especially for Hydrogen sulphide and Ammonia

Ph.D. Material Science (Aug.2010 – Nov.2014)

Manipal University and Material Research Centre (MRC), Indian Institute of Sciences, Bangalore, (Advisors: Prof. S.A.Shivashankar and Dr. Nalini.G.Sundram)

Thesis: Carbonaceous, Nanostructured Metal Oxides obtained from Metal organic precursors through inert- ambient, sealed- tube pyrolysis (STP)

Junior Research Fellow (Aug.2008-July 2010)

MRC, Indian Institute of Science, Bangalore) (Supervisors: Prof. S.A.Shivashankar and Prof.S.Sampath)

Theme of the Project:Synthesis and characterization of nanostructured Metal Oxides from Metalorganic precursors for MOCVD and ALD.

Research Assistant (Aug.2007-July 2008)

Indian Institute of Science, Dept. Organic Chemistry (Supervisor: Prof. N.Jayaraman,)

Project Theme: Synthesis and Studies of Poly (propyl ether imine) Dendrimers and their Catalytic Study of Palladium and Ruthenium metals.

Project Associate (July.2006-July.2007)

Indian Institute of Technology Madras, Department of Chemistry (Supervisor. Prof.G.Sundararajan and Prof. Santhosh Ghorbade)

Project Theme: Synthesis and studies of Asymmetric compounds for polymerization behaviours with heavy metals.

M.Phil. Thesis (2006- 2007)

Bharathidasan university, Tiruchirappalli(Advisor: Late.Prof.G.Sundararajan, IIT Madras and Dr.Saikumar, CLRI, Adyar, Chennai)

Thesis: Synthesis and Characterization of Glycerol Glycidyl Ether from various polymer technique.

M.Sc.Thesis (2004 -2006)

Bharathidasan University, Tiruchirappalli(Supervisor:Late.Prof.G.Sundaraarajan, IIT Madras and Dr.Sridharan, CLRI, Adyar, and Chennai)

Thesis : Synthesis of 1,2,3,4, Tetra-hydro- Quinoline & Studies on oxidation of 2-amino benzyl alcohol & Subsequent formation of sulphonamide.

Research Interests

My research interests mainly in materials and semiconductor metal oxide synthesis and characterization and implicate the product to device fabrication. It includes study and characteristics of materials elaborated with property analysis for various applications. Stoichiometry changes of nanomaterial is major advantage to study their nanostructure formations to promote the flexible electronics devices.

Publications

- P1.** A composition-dependent “re-entrant” crystallographic Phase Transition in the substitutional metal acetylacetonate complex $(\text{Cr}_{1-x}\text{Ga}_x)(\text{acac})_3$. **M.Srinidhi Raghavan**, S.A.Piyuh.Jaiswal, Nalini.G.sundaram and Shivashankar, *Polyhedron*, **2014**, **70**, 188–190.
- P2.** New metal-organic precursors for MOCVD applications: Synthesis, characterization, crystal structure and thermal properties of mixed-ligand Mg(II) complexes, S.Brahma, **M.Srinidhi**, T.Narashimamurthy and R.S.Rathore, Prof. S.A.Shivashankar, *Journal of Molecular Structure*, **2013**, **1035**, 416–420.
- P3.** Bis (acetylacetonato- $\eta^2\text{O}, \text{O}^{\prime}$)(pyridine- N) Zinc(II), Sanjaya Brahma, **M. Srinidhi**, S. A.Shivashankar, *Acta Crystallographica Section E*, E67, m819, **2011**.
- P4.** Synthesis of diamond from graphite-MgO composite prepared through $\text{Mg}(\text{acac})_2 \cdot \text{H}_2\text{O}$ under the high pressure and temperature, **M.Srinidhi Raghavan**, Prof.S.A.Shivashankar, (Manuscript Communicated to Journal of Crystal Growth)
- P5.** Detection of H_2S at high responses and recovery by Using carbon coated Indium Oxide Nanowire prepared at high temperature, **M.Srinidhi Raghavan**, Prof.NavakantaBhat, Prof.S.A.Shivashankar, (Manuscript Communicated to Sensor. Actuator B Chem)
- P6.** Ultra-selective Hydrogen sulfide sensor using Tungsten rich Tungsten oxide thin films. **M.Srinidhi Raghavan**, GirishMuralidharan, AmitavaPramanik, Prof.NavakantaBhat. (Communicated to **Sensor.Actuator.A Phy**)
- P7.** Highly selective Ammonia sensing using Titanium nanowires prepared through Hydrothermal methods. **M.Srinidhi Raghavan**, GirishMuralidharan, AmitavaPramanik, Prof.NavakantaBhat. (**Unilever R&D Bangalore, 64, Main Road, Whitefield, Bangalore 560066**)(Under the NOC process)

P8. High sensitive Hydrogen sulfide sensor using uniformly decorated Gold nanoparticles. **M.Srinidhi Raghavan**, GirishMuralidharan, Prof.NavakantaBhat. (**Unilever R&D, White field, Bangalore 560066**) (Under the preparation)

P9. Crystalline C₃N₄ and g-C₃N₄ synthesis from Anthranillic acid and Melamine through inert- ambient pyrolysis,**M.Srinidhi Raghavan**, **Prof.S.A.Shivashankar** (Manuscript communicated to Nature Scientific Reports.)

P10. Photoluminescence study of Indium substitute Gallium nanowires prepared at inert ambient pyrolysis at high pressure method, **M.Srinidhi Raghavan**, Prof.S.A.Shivashanagr (Manuscript communicated to Advance Materials)

Patents **P1.** A gas sensor for detecting a gas component, A Low level

Detection nearly 10 ppb Hydrogen sulphide through DC Sputtered Tungsten rich Tungsten oxide, **Srinidhi M**, Grish Muralidharan and AmitavaPramanik, Prof.NavakantaBhat, Mishra Vijay. Umashankar. **With Unilever R&D. White field Bangalore. (International Publication Number WO/2018/091293 A1- International patent published).**

P2. Nanostructured metal oxides prepared through inert Ambient pyrolysis at high pressure and temperature **Srinidhi.M**, and Prof.S.A.Shivashankar. (**Filing is in Progress**).

Completed Projects (During PhD)

- ❖ Carbonaceous metal oxide nano-composites: As electrode materials in electrochemical capacitor applications (**Funded by DST, India**)
- ❖ Carbon coated transition metal oxides for the application of Li-Ion batteries (**Funded by NPMASS, Govt. of India**)
- ❖ New method of Carbon composites synthesis through inert ambient chemical vapour deposition (**Funded by Ministry of Electronics and Information Technology**)

Completed Projects (During Post. PhD)

- ☯ Solid state gas sensors array for Toxic Malodorous Gases in the application of Breath analyser (**Hindustan Uniliver and Meity, India**)
- ☯ Indigenous Solid State NH_3 Sensor for lung diseases (**Deity funded project MITO084**)

Product Developed

- ☆ **Ultra-Sensitive Hydrogen Sulfide sensor using Tungsten rich Tungsten oxide for Breath analyser. (Delivered to Hindustan unilever Pvt.limited, Bangalore, India).**

Research Experience

- ◆ Synthesis and characterization of nanostructured materials through various techniques(Hydrothermal, Sol-gel method, combustion, wet-synthesis)
- ◆ Design, construction and maintain the production systems with controlling individual power' capabilities. Experience in installing/running the CVD system in a clean room environment.
- ◆ Developed a “true CVD” approach for growth of semiconductors with all precursors outside enabling heterostructures and doping. This route is compatible to today's semiconductor technology.
- ◆ Semiconductor process development for complete device fabrication – includes lithography, contacts and etching in a Class 1000/100 clean room.
- ◆ Phase change property studies of Carbon coated metal oxide composites for various applications.

Sophisticated Analytical Instruments Skills

☆ Fabrication Process

- ✚ Working in 1-100 clean room for metal oxide semiconductor device fabrication,
- ✚ Proficient in Tecport sputter coater, Optical Lithography, PECVD, RIE and DRIE, Sputtering and Wet chemical process.

☆ Gas sensing experiment

- ✚ Develop sensor arrays, by post processing CMOS integrated circuits.
- ✚ Breathe analyser for hazardous gases through optical lithography.

☆ Structural, Microstructural and Compositional Analysis

- ✚ Scanning electron microscopy (SEM), ICP-OES, XPS, XRD, Raman Spectroscopy, Photoluminescence (PL), FTIR, UV-NIR, TEM, EPMA, I/V.

☆ Synthesis Techniques

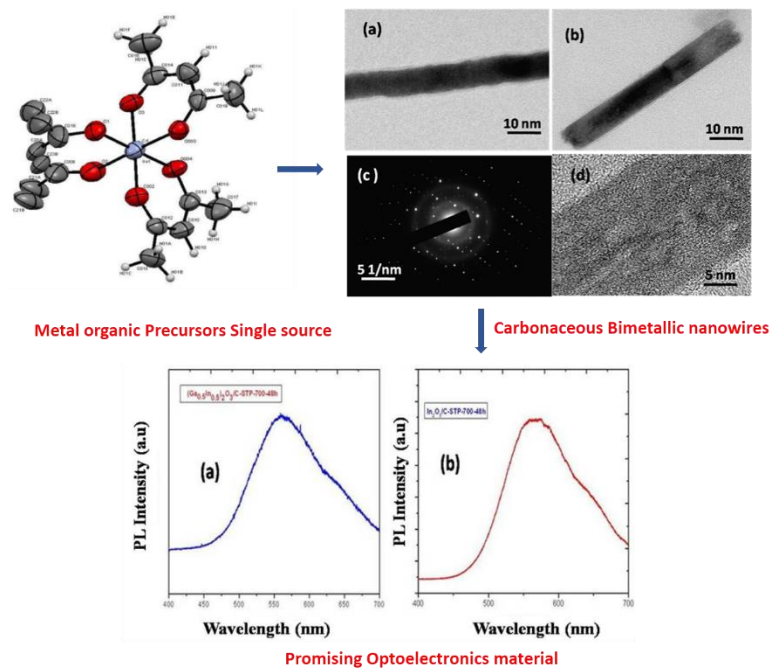
- ✚ Metal chalcogenides synthesized by wet-chemical method. Microwave synthesis, Machaon-chemical synthesis, Combustion and Solid State Reaction Routes.
- ✚ Proficient in high-pressure reaction conditions and Glove Box techniques for the manipulation of highly air sensitive Organometallic Compounds.

☆ In-line characterization

- ✚ Characterization tools like ellipsometer (measure film thickness), four probe measurement (measure sheet resistance), and dektak (measure step height after etching).

PhD Dissertation

A broad range of topics related to the synthesis of metal oxide nanocomposites (metals considered: Mg, Cr, Ga, In) and their applications. This is accomplished using the metal organic source materials, specifically metal acetylacetonates and Metal anthranilates (denoted as “acac&aaH”). The work specifically describes in detail the development of a novel synthesis technique that works at a moderately high pressure and a relatively low (reaction) temperature, is rapid and uses low-cost equipment. It employs sealed-tube pyrolysis (STP) in inert ambient for the synthesis of carbonaceous metal nanocomposites and carbon coated metal oxides. Emphasis has been placed on the study of synthesis and characterization of substituted carbonaceous metal oxides: specifically, **MgO/C**, **(Cr,Ga)₂O₃/C** and **(Ga,In)₂O₃/C**. As noted, the combination of carbon and a metal oxide produces a nanocomposite, with a wide range of applications like Gas sensor, PL diodes, optoelectronics and semiconductors. The synthesis technique plays an important role in determining the structural characteristics of the composite material, thus influencing its properties.



Post-PhD Research

- ◆ **Single Chip Micro-Gas-Sensor array** Gas sensor array device structure for monitoring health biomarker, namely H_2S , NH_3 , NO_2 is simulated, fabricated, packaged and tested, as described below in figure. The micro-heaters share a single suspended SiO_2 diaphragm, utilizing thermal proximity to achieve low power consumption ($\sim 8\text{--}10\text{mW}$ for 300°C). Sensor array elements are fabricated by customizing each element to sense a specific gas, using different sensing materials. Optimized thin films of DC sputtered- WO_3 , RF sputtered- TiO_2 , RF sputtered- WO_3 , are used for selective sensing for targeted gases. The sensor array is packaged on Kovar header and then characterized for gas sensing. It is demonstrated that the sensors exhibit good sensitivity and selectivity. We report a ultra-sensitive response to H_2S ($\sim 3100\%$ for 10 ppb), NH_3 ($\sim 1270\%$ for 3 ppm), NO_2 ($\sim 1948.8\%$ for 0.9 ppm) at operating temperatures of 250°C , 200°C , 150°C respectively.

Education and Qualification

Ph. D., in Materials Science (2010-2014), Materials Research Centre, Manipal University and Indian Institute of Science, Bangalore, India.

M.Phil. in Chemistry (2006-2007), Bharathidasan University, Tiruchirappalli, Tamil Nadu, India. **Percentage of Marks: 78 % (Outstanding)**

M.Sc., in Chemistry (2004-2006), St. Joseph's College, Bharathidasan University, Tiruchirappalli, India. **Percentage of Marks: 65.54% (Distinction).**

B.Sc., in Chemistry (2000-2003), Bharathiyar University, Coimbatore, India. **Percentage of Marks: 92.83% (Outstanding).**

Personal Information

Date of Birth : 25/ 07/1983

Gender/ Nationality : **Male/** Indian

Marital status : Single

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References

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Declaration

I hereby declare that the information and documents which I have mentioned above are true to the best of my knowledge and belief.

Yours Sincerely

Place: Bangalore, India.

M.SRINIDHI RAGHAVAN