

# SYNTHESIS AND CHARACTERIZATION OF SOME ORGANOMETALLOGELS AND THEIR APPLICATIONS



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Award of Degree

**Doctor of Philosophy**

By

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The present thesis described the synthesis, characterization and applications of novel metallogels, these smart materials have been grabbing an increasing interest due to the wide variety of applications in multidisciplinary areas like biomedical, pharmaceutical, catalysis and batteries. Our research dissection has been emphasized in the manufacture of metal-semiconducting (M-S) junction type devices using metallogels.

**Chapter 1** The current chapter deals with the exhaustive literature survey related to synthesis of metallogel. This chapter also discussed an overview and history of gel. The present chapter also discussed the properties and application of metallogels as well as objective of the current thesis work.

**Chapter 2** The present chapter furnishes the materials and the protocols used in the present thesis work. This chapter provides the list of chemical which have been used up throughout the experiments. This chapter also covers the detailed procedures of the various modern characterization techniques. In addition to this, it further covers semiconducting properties of synthesized metallogel and also stated about the fabrication of M-S junction based Schottky barrier diode.

**Chapter 3** Herein, we have developed a practical synthesis of new modular and functional metallogel, based on succinic acid-derivative and  $\text{Cu}(\text{OAc})_2$  in DMF. Gel phase material was confirmed by rheological experiments and also been established the mechanical stability of metallogel. Well-defined cross-linked nanofibers of supramolecular  $\text{Cu}^{2+}$  based metallogel were confirmed by SEM, TEM, and AFM analysis. The FT-IR, UV-vis, HR-MS and Job's plot established the mechanism of metallogel. The optical band-gap measurement of metallogel based on succinic acid-derived compound ( $\text{H}_4\text{L}$ ) and  $\text{Cu}(\text{OAc})_2$ , suggests the semiconducting nature of the metallogel. Additionally, we have fabricated an MS junction

thin-film electronic device by Ag metal and semiconducting Cu-H<sub>4</sub>L gel. The non-linear charge transportation of the device obtained from the  $I-V$  characteristic graph was confirmed the fabrication of the Schottky diode. Thus, the present study of ITO/Cu-H<sub>4</sub>L/Ag advocates the future possibility of achieving supramolecular Cu<sup>2+</sup> metallogel based electronic devices for advanced technology.

**Chapter 4** The novel modular and functional metallogel we have synthesized here is based on trimesic acid and Cu(OAc)<sub>2</sub>·H<sub>2</sub>O in DMF, and it was developed using a viable synthesis method. The mechanical stability and confirmation of its gel phase were both demonstrated by rheological studies. SEM and TEM investigation indicated that the supramolecular Cu-TMA-based metallogel contains a clearly defined 3D- interconnected nano-fibrous network. The mechanism of metallogel was established by UV-vis, FT-IR, and ESI-MS analysis. By measuring the optical band gap of Cu-TMA metallogel, it was found that the substance possesses a semiconductive nature. Furthermore, we have developed an MS junction thin-film electronic device by using Ag metal and semiconducting Cu-TMA metallogel. The  $I-V$  characteristics indicate the formation of a Schottky Barrier Diode. Thus, the current study on ITO/Cu-TMA/Ag advocates the future advanced applications of gelatinous smart materials and their suitability for use in conductive devices and battery electrolytes

**Chapter 5** we synthesized a stable supramolecular Mg-ALA metallohydrogel by combining magnesium nitrate hexahydrate and Allylamine (ALA) in a water-based solution. Rheological studies verified that these Mg-ALA metallogels possess a high storage modulus and remain thermally stable. The morphology and structure of the resulting supramolecular

metallogel were characterized using UV-Vis, FT-IR (Fourier-transform infrared spectroscopy), and FESEM (Field Emission Scanning Electron Microscopy). To evaluate its semiconducting properties, we determined the energy band gap and explored various electrical behaviors, including current-voltage characteristics and rectification in the metal-semiconductor (MS) junction-device. Additionally, exploiting the device's non-linear rectifying behavior, we successfully crafted an active electronic component a Schottky Diode. In conclusion, our developed semiconducting Mg-ALA metallogel exhibits great promise and efficiency, paving the way for potential applications in a wide range of future optoelectronic devices.

