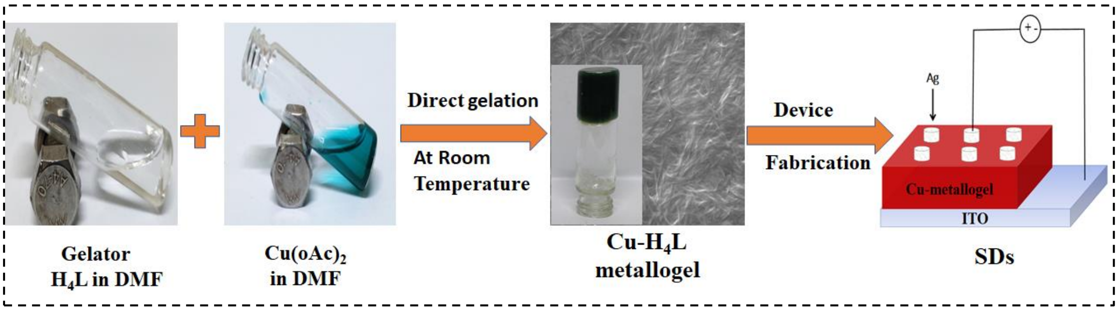
Preface

This thesis primarily focuses on 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.

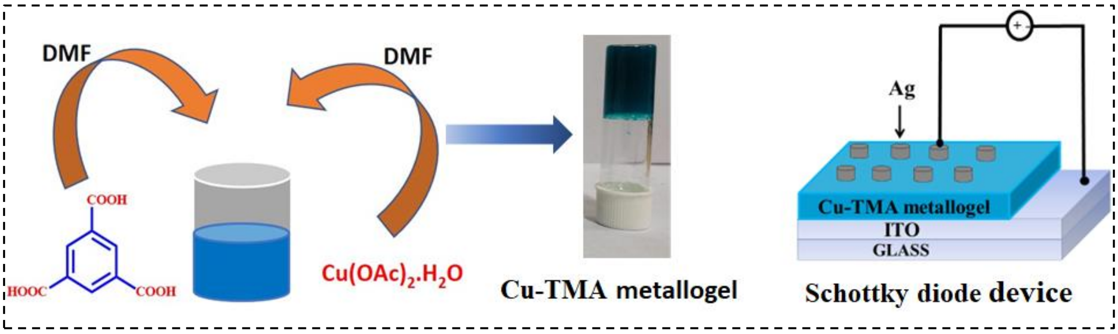
Chapter 1 Gels have been synthesized since the nineteenth century, but a pinpoint definition of gel is still a matter of argument. Gels are generally identified by their physical appearance and behavior as soft solid-like character with no flow of trapped liquid. Generally, a very small amount is sufficient to immobilize the large amount of solvent. A gelator can be utilized to characterize its macromolecular structure i.e. gel which could help correlate the characteristic properties of material in micro and macro level organization. The fact may be useful in unveiling the direct relation between small changes in the gelator and the outcome in a macroscopic state. The most striking aspect of low molecular weight organic gelator (LMWGs) is that they usually possess better multistimuli responsive behaviors towards external stimuli and simple synthetic modifications in the gelator structure may lead to drastic changes in the synthesized gel. These factors are well elaborated in the present thesis.

Chapter 2 deliberates the complete description of materials and experimental methodologies for the synthesis of supramolecular metallogel which have been used for active electronic device fabrication. The current chapter also discusses the various modern characterization techniques such as Fourier Transform Infrared (FTIR) Spectroscopy, UV-visible spectroscopy, X-ray diffraction (XRD), Transmission Electron Microscopy (TEM), Energy-Dispersive X-ray Spectroscopy (EDAX). FESEM (Field Emission Scanning Electron Microscopy). In addition to this, it further covers the semiconducting properties of synthesized metallogel and also states the fabrication of an M-S junction-based Schottky barrier diode.

Chapter 3 In the present study, a stable supramolecular Cu (II)-metallogel has been synthesized via Copper (II) acetate monohydrate and succinic acid, engineered as a low molecular weight organic gelator. The mechanical assets of Cu-H_4L metallogel have been explored through the rheological investigation. Further, the aggregation of synthesized metallogel has been well established by several experiments using Job's plot, HR-MS (High Resolution Mass Spectrometry). Apart from this, the morphology of the synthesized supramolecular metallogel was scrutinized by FE-SEM, TEM, and AFM study, exposing the self-assembled thread-like morphology of Cu-H_4L metallogel. The functional group, elemental composition, crystalline behaviour, and thermal stability of the Cu-H_4L metallogel were probed by FT-IR, XPS, P-XRD, and TGA studies, respectively. The optical band-gap measurement of metallogel based on succinic acid-derived compound (H_4L) and $Cu(OAc)_2$, suggests the semiconducting nature of the metallogel. Additionally, we have fabricated an MS junction thin-film electronic device with Ag metal and semiconducting Cu-H_4L gel. The non-linear charge transportation of the device obtained from the I–V characteristic graph confirmed the fabrication of the Schottky diode.



Chapter 4 A stable supramolecular Cu-TMA metallogel was synthesized by using Copper (II) acetate monohydrate and trimesic acid (TMA) as a low molecular weight organic gelator in DMF. The rheological studies confirmed that the synthesized Cu-TMA metallogels have high storage modular. The FT-IR and HR-MS analysis confirmed the metal-ligand aggregation in the produced metallogels. Apart, FESEM and TEM probed the shape and morphology of the synthesized supramolecular metallogel like self-assembled fibrous structure. However, TGA analysis confirmed the high thermal stability of metallogel. To explore the semiconducting properties of metallogel, we calculate the energy band gap and, other electrical properties such as current-voltage characteristics and rectifying behaviour for metal-semiconductor (MS) junction-device have been properly investigated. In addition to this, based on the non-linear rectifying behaviour of the device, we have fabricated an active electronic device, a Schottky Diode, having high Rectification (I_{on}/I_{off}) ratio. Consequently, our synthesized semiconducting Cu-TMA metallogel is fruitful and efficient and could be applied to various other optoelectronic devices in future.



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, and FESEM. 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.