

# Chapter 1

# Introduction to

# Chalcogenide–Based

# Nanocomposites


# Advances in

# Optoelectronics

# Energy Systems and

# Sustainability

**Periasamy Palanisamy**

 <https://orcid.org/0000-0003-1069-5822>

*Nehru Institute of Engineering and Technology, Anna University, Coimbatore, India*

**S. Satheeskumar**

*K.S. Rangasamy College of Technology, India*

## **ABSTRACT**

*Chalcogenide nanocomposites are nanosized materials wherein chalcogen elements (sulfur, S; selenium, Se, and tellurium, Te) are combined with a wide range of metals and/or semiconducting materials, have attracted researchers' interest due to their peculiar optoelectronic, energy storage and environmental sanitization characteristics. This chapter describes recent progress on the synthesis, properties, and applications of nanocomposites based on chalcogenides in the field of optoelectronics, energy, and sustainability. Potential applications include solar cells, light-emitting devices, photodetectors, energy storage systems (such as batteries and supercapacitors)*

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*and environmental sustainability-related fields such as photocatalysis and water purification. This chapter describes new trends and perspectives in the fabrication of chalcogenide nanocomposites, which are proposed as advanced materials for next-generation energy technology, including eco-friendly applications*

## **INTRODUCTION**

The chalcogenides are compounds containing elements from the chalcogen group of the periodic table (S, Se, Te). They are well known for their extraordinary properties, which derive from the strong interactions between the chalcogen atoms, metals and semiconductors (Bouroushian, 2010). The as-prepared materials have diverse electronic, optical, and thermal properties, and thereby can be used as versatile materials in optoelectronics, energy storage, and environmental protection (Ha et al., 2023). Chalcogenides, such as cadmium selenide (CdSe) and copper indium gallium selenide (CIGS), have been used as solar cells and light-emitting devices (LEDs) in the past. Nevertheless, thanks to these properties, many applications emerged after the combination with nanomaterials, which is the fabric to produce chalcogenide composite material. Composite materials of chalcogenides were prepared with other nanomaterials, such as graphene or carbon nanotubes, to improve their efficacy, (Stamford & Azapagic, 2019).

Another aspect of the relevance of chalcogenide-based nanocomposites is their capability to be tailored at the nanoscale, where quantum confinement and high surface-area phenomena play a significant role, leading to extraordinary properties compared to the respective bulk materials. These progresses in the nanocomposites led to better optical absorption, charge transport characteristics, as well as mechanical properties and opened up new opportunities in the newly arising areas such as flexible electronics, renewable energy and sustainable technology (Voigt et al., 2022). Chalcogenide-based nanocomposites are composites that involve chalcogenide compounds with other nanostructured materials. The composites offer the combined benefits of both components, enhancing performance in various applications. Those materials are usually modified by adding chalcogenide with other parts like metals, carbon-based nanomaterials and metal oxides, (Singh et al., 2015).

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