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# THE MULTIFACETED POTENTIAL OF NANOMATERIALS: SYNTHESIS, CHARACTERIZATION, AND EMERGING APPLICATIONS

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## INTRODUCTION

*Nanomaterials, with their nanoscale dimensions and unique properties, have transformed science and engineering. This paper analyzes the synthesis, characterization, and applications of nanomaterials, highlighting recent advancements. We explore synthesis methods like chemical vapor deposition and sol-gel processes, and advanced characterization techniques such as TEM and XRD. Applications in biomedicine, energy, and environmental sectors are discussed, emphasizing their potential and future challenges in safety and biocompatibility.*



## SYNTHESIS METHODS

- Chemical vapor deposition
- sol-gel processes
- hydrothermal synthesis
- biogenic approaches.

## CHARACTERIZATION TECHNIQUES

- TEM
- SEM
- XRD
- spectroscopic methods.

## Applications & Results

- **Biomedicine:** drug delivery, imaging, therapy.
- **Energy:** photovoltaic cells, batteries, supercapacitors.
- **Environment:** water purification, pollutant remediation.

*The conclusion addresses challenges and future directions in nanomaterial research, emphasizing the need for standardized safety and biocompatibility protocols, and highlights the transformative potential of nanomaterials across various scientific and industrial sectors.*

