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Introduction

Nanochemistry is an interdisciplinary eld that merges the principles of chemistry with the unique phenomena exhibited by materials at the nanoscale, typically in the range of 1 to 100 nanometers. It lies at the heart of nanoscience and nanotechnology, o ering transformative potential in elds ranging from medicine to energy, electronics, and beyond [1]. is article delves into the fundamental concepts, applications, and implications of nanochemistry. In the vast realm of scienti c disciplines, few elds have captured the imagination and promise of humanity quite like Nano chemistry. Emerging at the con uence of nanotechnology and chemistry, this groundbreaking area of study is dedicated to manipulating matter on an atomic and molecular scale to unlock unprecedented possibilities [2]. As a fundamental pillar of nanoscience, Nano chemistry explores the synthesis, characterization, and application of nanoscale materials, bridging the gap between the macroscopic world we observe and the quantum-scale interactions that govern the behavior of matter at its smallest dimensions [3].

e term “Nano” originates from the Greek word “Nano's,” meaning “dwarf,” and in scienti c parlance, it refers to one-billionth of a meter (10 9 m). At this scale, materials exhibit unique physical, chemical, and biological properties that di er signi cantly from their bulk counterparts [4]. Nano chemistry harnesses these distinctive features to revolutionize industries ranging from medicine and energy to electronics and environmental science. By designing and engineering materials at the nanoscale, scientists can achieve remarkable enhancements in e ciency, functionality, and sustainability. e advent of Nano chemistry is o en linked to the pioneering work of scientists like Richard Feynman, who famously envisioned a future of atomic-scale manipulation in his 1959 lecture, " ere's Plenty of Room at the Bottom." Since then, advancements in tools such as scanning tunneling microscopes (STM) and atomic force microscopes (AFM) have transformed this vision into a tangible reality, enabling researchers to visualize and control matter at an unparalleled level of precision [5].

One of the key aspects of Nano chemistry lies in its interdisciplinary nature. It draws upon principles of physics, biology, materials science, and engineering to address complex challenges. For instance, the design of nanoparticles for targeted drug delivery in medicine involves not only chemical synthesis but also an understanding of biological pathways and pharmacokinetics [6]. Similarly, the development of nanostructured catalysts for green energy production requires insights into surface chemistry and reaction dynamics. Nano chemistry has already demonstrated its transformative potential in numerous applications. In the medical eld, nanoparticles are being used to improve imaging techniques, deliver drugs with pinpoint accuracy, and even combat diseases like cancer at a cellular level [7]. In the realm of renewable energy, nanomaterials have paved the way for more e cient solar cells, advanced batteries, and lightweight materials for energy storage. Environmental science bene ts from nanoscale solutions in water puri cation, pollution control, and sustainable agriculture. Furthermore, Nano electronics and quantum computing are revolutionizing the technological landscape, driving progress toward

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Industrial Chemistry

- Common techniques: Lithography, ball milling, and laser ablation.

Bottom-up approach

- Constructs nanoparticles atom by atom or molecule by molecule.
- Common techniques: Sol-gel processes, chemical vapor deposition, and self-assembly methods.
- ese techniques o en employ sophisticated instrumentation such as scanning electron microscopes (SEM) and atomic force microscopes (AFM) for characterization.

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