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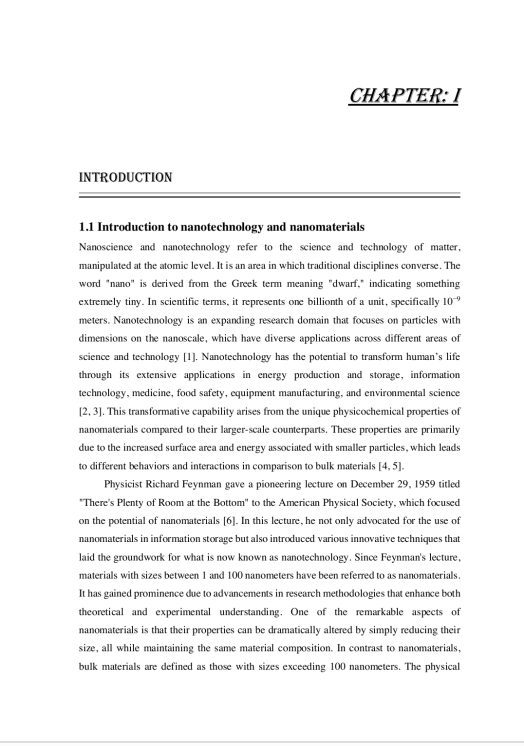

CHAPTER: I

INTRODUCTION

1.1 Introduction to nanotechnology and nanomaterials

Nanoscience and nanotechnology refer to the science and technology of matter, manipulated at the atomic level. It is an area in which traditional disciplines converse. The word "nano" is derived from the Greek term meaning "dwarf," indicating something extremely tiny. In scientific terms, it represents one billionth of a unit, specifically 10^{-9} meters. Nanotechnology is an expanding research domain that focuses on particles with dimensions on the nanoscale, which have diverse applications across different areas of science and technology [1]. Nanotechnology has the potential to transform human's life through its extensive applications in energy production and storage, information technology, medicine, food safety, equipment manufacturing, and environmental science [2, 3]. This transformative capability arises from the unique physicochemical properties of nanomaterials compared to their larger-scale counterparts. These properties are primarily due to the increased surface area and energy associated with smaller particles, which leads to different behaviors and interactions in comparison to bulk materials [4, 5].

Physicist Richard Feynman gave a pioneering lecture on December 29, 1959 titled "There's Plenty of Room at the Bottom" to the American Physical Society, which focused on the potential of nanomaterials [6]. In this lecture, he not only advocated for the use of nanomaterials in information storage but also introduced various innovative techniques that laid the groundwork for what is now known as nanotechnology. Since Feynman's lecture, materials with sizes between 1 and 100 nanometers have been referred to as nanomaterials. It has gained prominence due to advancements in research methodologies that enhance both theoretical and experimental understanding. One of the remarkable aspects of nanomaterials is that their properties can be dramatically altered by simply reducing their size, all while maintaining the same material composition. In contrast to nanomaterials, bulk materials are defined as those with sizes exceeding 100 nanometers. The physical

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