Handbook of Nanoparticles

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Editor

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With 560 Figures and 132 Tables

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Preface

Most of the physical properties of materials are changed by changing the scale of the particles from micrometer to nanometer. One of the reasons for these changes is increasing the surface-to-volume ratio, and another one is changing the size of the moving object inside the territories in which quantum effects are ruling. In fact, the ratio of internal surface atoms increases, and the properties of the surface atoms rule over the internal atoms' behavior. These changes affect the properties and interaction of the particles. Increasing the surface is an important factor in the proficiency of the catalysts. Also increasing the surface (shell surface) of the nanoparticles can enormously affect the interactions of the materials such as nanocomposites and can change the chemical, mechanical, and electrical properties of such materials. Considering the bigger size of nanoparticles in comparison to the wavelength of the visible light, they can be used in packaging applications, makeup techniques, adornment, and color coatings. According to the quantum effects or increasing the surface atoms, some of the properties of the nanoparticles may not be easily predictable. For example, it has been lately shown that the structures of the silicon nanoparticles are nanospherical with 40–100 nm diameter. These nanoparticles are not only harder than silicon but also as hard as diamond.

Nanoparticles have been used for many years, but probably they were first used in glass utensils of the ancient Chinese dynasty. There is a fourth-century Roman cup named as "Lycurgus Cup" held in the British Museum with the relief sculpture of King Lycurgus. The cup structure is mainly made of silicon dioxide and a sodium oxide and calcium coating with few gold nanoparticles. The presence of gold nanoparticles results in changing the color of the cup. When light radiates inside the cup, it turns green, and when light radiates outside the cup, it turns red. The main origin of this phenomenon was unknown in those times. Lately, a vast variety of nanoparticles have been fabricated using different types of materials. The most important and common type of these nanoparticles are ceramics. One of the most important parts of these ceramic nanoparticles is metal oxides such as titanium oxides, iron oxides, aluminum oxides, etc. As it is clear, the nanoparticles should be smaller than 100 nm. A lot of novel applications have emerged for the particles in this range of size. Using nanoparticles in metallic ceramics and metal oxides increases their hardness in comparison to their prior state in all sizes. Reduction

in the size of the particles changes the reactivity and the electronic, physical, chemical, magnetic, and optical properties of these materials.

The speed of progress in research around nanoparticles increased during recent years. As a result, this handbook aims to gather different aspects of nanoparticles, especially around their synthesis and surface modification, besides their advances.

I would like to appreciate all contributors of this handbook and thank them for their hard work, patience during the preparation of this handbook, and also their high-quality chapters. We hope the publishing of this handbook will help all researchers to benefit from this collection.

Tehran, Iran Mahmood Aliofkhazraei
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About the Editor

Dr. Mahmood Aliofkhazraei is assistant professor in the materials engineering department at Tarbiat Modares University. Dr. Aliofkhazraei's research interests include nanotechnology and its use in surface and corrosion science. One of his main interests is plasma electrolysis, and he has published more than 40 papers and a book in this area. Totally, he has published more than 12 books and 90 journal papers. He has given some invited talks including several keynotes in several countries. Aliofkhazraei has received several awards including the Khwarizmi award, IMES medal, INIC award, best thesis award (multiple times), best book award (multiple times), and the best young nanotechnologist award of Iran (two times). He is on the advisory editorial board of several materials science and nanotechnology journals. He is a member of the National Association of Surface Sciences, Iranian Corrosion Association, and National Elites Foundation of Iran.

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