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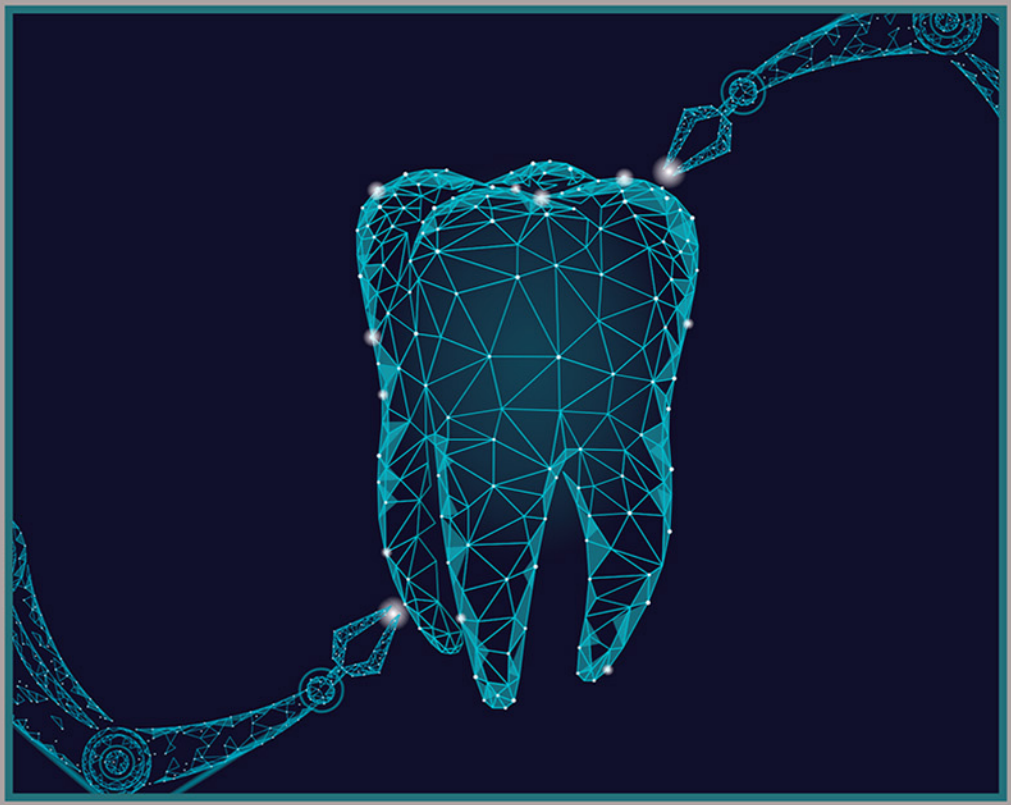

NANOTECHNOLOGY IN CONSERVATIVE DENTISTRY

Edited by
MONA ISMAIL RIAD
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ELSEVIER

Nanotechnology in Conservative Dentistry

Woodhead Publishing Series in Biomaterials

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Dedication

To my parents for their encouragement and support

To my family for their overwhelming love and understanding

To the soul of my dear professors Prof. Dr. Mai Yosry and Prof. Dr. Amr Shabka Professors of Conservative Dentistry, Cairo University, Egypt

—*Shereen Hafez Ibrahim*

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Preface

Nanotechnology will definitely pave the way for the development of tools which would allow clinicians to diagnose and treat oral diseases at their earliest stage. The new era of nanodentistry will encompass precisely regulated analgesia, tooth regeneration, complete cure of hypersensitivity, and rapid orthodontic treatment. Nanotechnology in the future will have a great impact on dental diagnostics, prevention, and therapeutics. However, our book is very specific focused on the use of nanotechnology in the field of conservative dentistry covering all its aspects starting from diagnosis to restorative materials extending to tissue engineering and regeneration in comprehensive and analytical way, nevertheless cytotoxicity, hazards, and safety of these nanotechnology. This book includes all recent publications till 2020.

This textbook is relevant to researchers, professors, associate professors, and postgraduate students, in the dental field interested in nanotechnology, nanobiomaterials science, biomimetics, and dental materials. Moreover, this book could be used as a nanotechnology course in conservative dentistry for doctor degree or master degree programs.

Recent development in the field of material science and biomimetic engineering has brought on significant advances in material properties. This was especially achieved via nanometric based materials. Nowadays, the nanotechnology is widely used in different fields in industry as well as in the medical field especially in drug production and imaging. Moreover it has many effective and safe applications in the treatment of cancer by identifying and targeting the diseased cells, also drug delivery mode. Conversely the utmost benefits of nanotechnology applications are raised in the development of innovative bioactive medical treatments.

Our book is very specific. It focused on the use of nanotechnology in the field of conservative dentistry covering all its aspects starting from diagnosis to restorative materials extending to tissue engineering and regeneration in comprehensive and analytical way, nevertheless cytotoxicity, hazards, and safety of these nanotechnologies. This book includes all recent publications till 2020. This book takes a deep look into the health hazards research in the last decade focusing on nanomaterials used in restorative dentistry.

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Suggested reading

Keerthana, S., & Kumar, A. (2020). Potential risks and benefits of zinc oxide nanoparticles: A systematic review. *Critical Reviews in Toxicology*, *50*(1), 47–71. Available from https://doi.org/10.1080/10408444.2020.1726282.

Schmalz., et al. (2018). Scientific update on nanoparticles in dentistry. *International Dental Journal*, *68*(5), 299–305. Available from https://doi.org/10.1111/idj.12394.

Shashirekha, G., Jena, A., & Mohapatra, S. (2017). Nanotechnology in dentistry: Clinical applications, benefits, and hazards. *Compendium of Continuing Education in Dentistry*, *38* (5), e1–e4.

Background and purpose

Nanotechnology has greatly transfigured the dentistry field. Recent development in the field of material science and biomimitic engineering has brought on significant advances in material properties. This was especially achieved via nanometric based materials. Nanomaterial is currently considered standard in many restorative materials. Hence the utmost benefits of nanotechnology applications are raised in the development of innovative bioactive medical treatments. Dental applications of nanomaterials not only created a significant improvement in clinical treatments but also growing concerns regarding their biosecurity. Their high reactivity makes them a potential hazard for humans on a cellular level. As these restorative nanomaterials containing certain nanoparticles that remain functional in oral cavity over prolonged periods, it is mandatory to have the knowledge about their beneficial effects, their different clinical applicability in dentistry especially in Conservative dentistry regarding FDA approval, nevertheless, their toxicological or side effects in humans, cost effectiveness, and availability. Moreover, discussing the future prospective for dental tissue engineering was found exciting.

Acknowledgment

First, we are so grateful to *GOD* for blessing us throughout our life and for guiding and helping us to achieve this work. I must express my very profound gratitude to *our families* for providing us with unfailing support and continuous encouragement throughout our life.

We would like to thank with gratitude *all our Professors of Conservative Dentistry, Cairo University*, for their endless support and guidance. Their generous help was beyond imagination, and their kindness and patience were the light through the path; they have been a role model to everyone. Thank you for your valuable time, cooperation, and generosity which set this work possible as it is till the end.

We would also like to express our sincere thankfulness to the coauthors and collaborators for their contributions, support, and generous help in every way they could, for putting so much effort in this work, and for their valuable contribution in this work. Thank you again for your time, without you nothing would have been possible and this book would have not seen the light.

CHAPTER 1

Overview of emerging nanotechnology strategies in dentistry

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1.1 Nanotechnology and nanoscience

Nanotechnology and nanoscience refer to the manipulation of matter at atomic, molecular, and supramolecular scales. Nanotechnology and nanoscience investigations involve studies related to their applications in different branches including chemistry, biology, physics, materials science, and engineering.

1.2 Nanometer

One nanometer is a billionth of a meter, that is, 10^{-9} times 1 m.

Symbol	Name	Factor
y	yokto	10^{-24}
z	zepto	10^{-21}
a	atto	10^{-18}
f	femto	10^{-15}
p	pico	10^{-12}
n	nano	10^{-9}
μ	micro	10^{-6}
m	milli	10^{-3}
c	centi	10^{-2}
d	deci	10^{-1}

However, something as small as an atom is impossible to see with the naked eye.

Microscopes needed to view things at the nanoscale were invented about 30 years ago. Two common types of microscopes are:

- Scanning tunneling microscope
- Atomic force microscope (Fig. 1.1)

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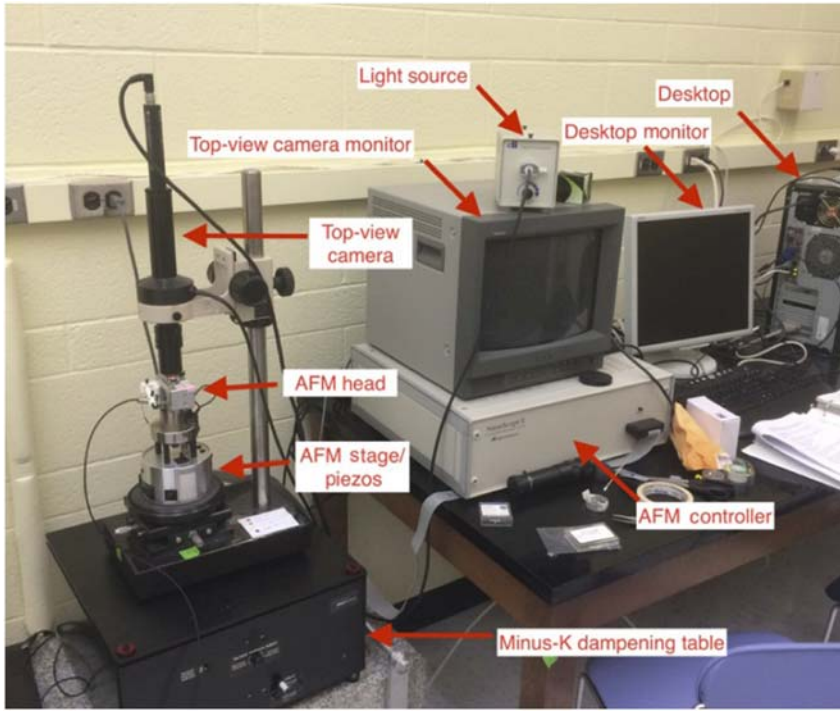

Figure 1.1 Atomic force microscope.

1.3 Champions of nanotechnology

The most prominent researchers and scientists in the field of nanotechnology are:

- The American physicist Richard Feynman

  He said, "There's plenty of room at the bottom," which is often held to have provided inspiration for the field of nanotechnology.
- Japanese scientist Norio Taniguchi

  He is the first scientist to introduce the term "nanotechnology" to describe a technology that creates objects and features on the order of a nanometer.
- American engineer Eric Drexler

  He is the engineer who conducted seminal studies on the potential of molecular nanotechnology.