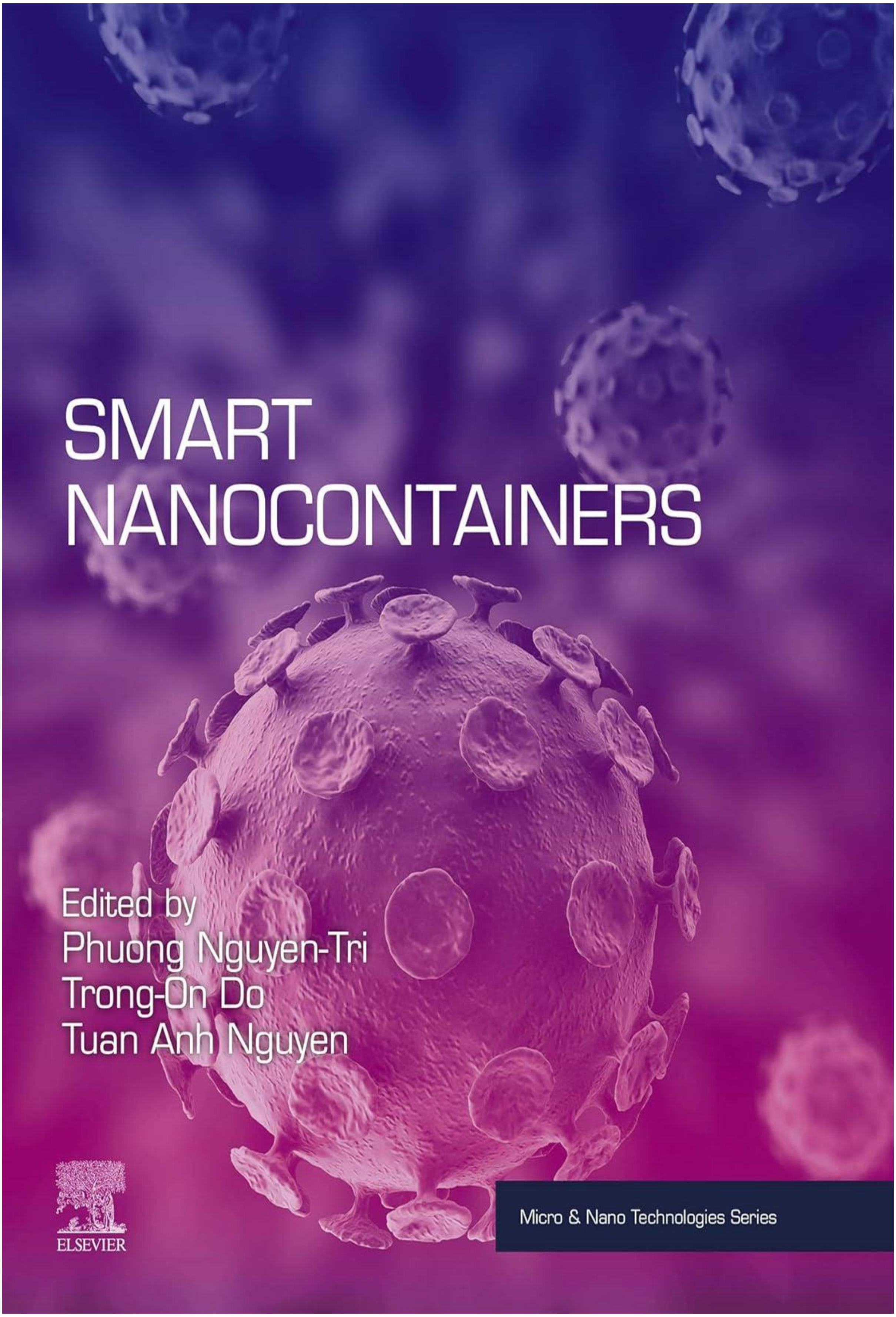
SMART
NANOCONTAINERS
Edited by
Phuong Nguyen-Tri
Trong-On Do
Tuan Anh Nguyen
ELSEVIER
Micro & Nano Technologies Series

## Description

*Smart Nanocontainers* explores the fundamental concepts and emerging applications of nanocontainers in biomedicine, pharmaceuticals and smart materials. In pharmaceuticals, nanocontainers have advantages over their micro-counterparts, including more efficient drug detoxification, higher intracellular uptake, better stability, less side effects and higher biocompatibility with tissue and cells. In materials science, such as coating technology, they help by making coatings smarter, stronger and more durable. This important reference will help anyone who wants to learn more on how nanocontainers are used to provide the controlled release of active agents, including their applications in smart coatings, corrosion, drug delivery, diagnosis, agri-food and gas storage.

## Key Features

- Discusses how the molecular design of nanocarriers can be optimized to increase performance
- Explores how nanocarriers are being used to produce a new generation of active coatings
- Explains how nanocarriers are being used to deliver more effective nanoscale drug delivery

## Details

| ISBN | Language | Published | Copyright |
|---|---|---|---|
| 978-0-12-816770-0 | English | 2020 | Copyright © 2020 Elsevier Inc. All rights reserved. |

FEEDBACK

# Table of contents



Actions for selected chapters

Select all / Deselect all

Export citations

Smart Nanocontainers

Micro and Nano Technologies

2020, Pages 459-466


# Chapter 27 - Nanocontainer for environmental applications

L.R. Gonsalves [a], R.K. Kunkalekar [b]

[a] Parvatibai Chowgule College of Arts and Science (Autonomous), Margao, Goa, India

[b] Department of Chemistry, Goa University, Taleigao Plateau, Goa, India

Available online 24 January 2020, Version of Record 24 January 2020.

Chapter 27

# Nanocontainer for environmental applications

L.R. Gonsalves[a] and R.K. Kunkalekar[b]

[a]*Parvatibai Chowgule College of Arts and Science (Autonomous), Margao, Goa, India,* [b]*Department of Chemistry, Goa University, Taleigao Plateau, Goa, India*

## 1 Introduction

Nanocontainers are versatile materials largely due to their intrinsic properties such as large surface area, low density, abundant inner void space, and many other optical, magnetic, and catalytic properties [1–4]. Besides its myriad properties, the specific composition of the shell material and the encapsulated material within the shell is the key that governs its function and unlocks its potential. For example, the void space inside the hollow shell could be used as nanocontainer or reactor; when filled with different materials, either inside the hollow void space or the porous shell, they could serve as carriers for drug delivery, gas storage, and corrosion inhibitors as discussed in the previous chapters. In this chapter, we will introduce the properties and applications of nanocontainers pertaining to environmental remediation and conservation of artworks.

## 2 Water treatment

Hollow nanomaterials possess relatively large surface area, high porosity, and high catalytic activity and thus are quite suitable for applications of wastewater treatment and environment remediation [5–9] such as adsorption of organic pollutant, degradation of dyes, and removal of heavy metal ions. Due to their large surface area, hollow nanomaterials, such as carbon nanotubes or hollow fibers, have strong affinity toward dyes and organic pollutants. Materials like carbon nanotubes [10, 11], double-shelled hollow silica [12], $ZnV_2O_4$ hollow spheres [13], and hematite hollow spindles and microspheres [14] have been synthesized and used for the adsorption and removal of organic dyes and other toxic pollutants in water. Das et al. [10] indicated the promising application of CNT membranes in sea and brackish water desalinations. Fig. 1 presents a prototype of their CNT membranes.

The catalytic property of certain hollow nanomaterials could be utilized during the wastewater or pollutant treatment. For example, the degradation of eosin Y and methylene blue using hollow copper microspheres as catalyst [15]. Eosin Y (EY) and methylene blue (MB) are widely used as dyes for printing and leather, as photosensitizers on semiconductors, and as fluorescent pigments; these are also used to stain histological tissue sections. The direct release of wastewater containing EY and MB causes serious environmental problems due to their dark color and toxicity. Traditional techniques to remove excess EY and MB, such as adsorption onto activated carbon or membrane separation, are based on phase transformation. Biological methods are also ineffective at decolorization of EY and MB, because of the stability and complex aromatic structures of the dyes. The use of nanocontainer catalyst is found to be particularly beneficial in this case. The copper microspheres show good catalytic activities in degradation reactions of dyes and maintain their catalytic activity even when reused multiple times. The reaction rate of eosin Y and methylene blue degradation is enhanced 7.5–15 times by hollow copper microspheres as compared with the control test. Similarly, $MnO_2$ hierarchical hollow nanostructures are utilized for the removal of Congo red dye, a commonly used dye in the textile industry. It is estimated that 1 g of hollow microsphere $MnO_2$ can remove about 60 mg Congo red from the wastewater. The electrostatic attraction between the manganese oxide surface and the Congo red species in solution at pH 7.6 is responsible for the dye removal [16].

In another process, mesoporous F-$TiO_2$ hollow microspheres have been demonstrated for concurrent photocatalysis and membrane water purification using methylene blue (MB) as a probe molecule to compare the photocatalytic activity and the membrane filtration performance with the commercially available Degussa P25 $TiO_2$ (average particle size: 25 nm). The

**Smart Nanocontainers**. https://doi.org/10.1016/B978-0-12-816770-0.00027-7