

Sustainable Materials and Technology

Imran Uddin *Editor*

Sustainable Nanomaterials

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Imran Uddin
Nanolab, Environmental Mineralogy
Research Group
Research Institute of Biomolecular
and Chemical Engineering
University of Pannonia
Veszprém, Hungary

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Exploration of Advances in Sustainable Nanomaterials in Textile Industries



Tahmeena Khan, Saman Raza, and Shashi Bala

Abstract The modern textile industry is observing a constant demand for novel and sustainable fabrics resulting in huge improvements in mechanical strength, texture and durability by infusing elements of nanotechnology. In recent times the advent of smart textiles has resulted from the combination of conventional materials with smart nanomaterials. Smart textiles or fabrics can adapt to different environmental conditions by altering their characteristic features accordingly. Nanotechnology is being explored to design sustainable fabrics which are infused with different properties like microbial and ultraviolet resistance, hydrophobic, etc. This chapter aims to explore the recent advances in the field of textile designing via the conjugation of nanotechnology. The advances which are of great utility such as the introduction and functionalization of nanomaterials in textiles and the development of smart and cost-effective, efficient and wearable fibres for the fashion industry, personal and healthcare are summarized in the chapter. Along with the benefits, drawbacks like the nanotoxicity of the fabricated textiles and the remedial strategies are also discussed.

Keywords Smart textile · Sustainability · Nanomaterials · Environment · Nanotoxicity

T. Khan (✉)

Department of Chemistry, Integral University, Lucknow, U.P. 226026, India
e-mail: tahminakhan30@yahoo.com

S. Raza

Department of Chemistry, Isabella Thoburn College, Lucknow, U.P. 226007, India

S. Bala

Department of Chemistry, University of Lucknow, Lucknow, U.P. 226007, India

104. Uğur SS, Bilgiç M (2017). *Bilge Int J Sci Technol Res* 1:79–86
105. Quadros ME, Pierson R, Tulve NS, Willis R, Rogers K, Thomas TA et al (2013) *Environ Sci Technol* 47(15):8894–9901
106. von Goetz N, Lorenz C, Windler L, Nowack B, Heuberger M, Hungerbühler K (2013) *Environ Sci Technol* 47(17):9979–9987
107. Choi O, Deng KK, Kim N-J, Ross L, Surampalli RY, Hu Z (2008) *Water Res* 42(12):3066–3074
108. Brouwer D (2010) *Toxicol* 269(2):120–127
109. Rather LJ, Zhou Q, Ganie SA, Li Q (2020) *Advances in functional finishing of textiles*. Springer, Singapore, pp 57–83
110. Mitrano DM, Limpiteeprakan P, Babel S, Nowack B (2016) *Environ Sci: Nano* 3:375–387
111. Sahu SC, Hayes AW (2017). *Toxicol Res Appl* 2397847317726352
112. Sukhanova A, Bozrova S, Sokolov P, Berestovoy M, Karaulov A, Nabiev I (2018) *Nanoscale Res Lett* 13(1):1–21
113. Grumezescu AM (ed) (2017) *Nanoscale fabrication, optimization, scale-up and biological aspects of pharmaceutical nanotechnology*. William Andrew, Norwich, NY, USA
114. Nallanthighal S, Chan C, Murray TM, Mosier AP, Cady NC, Reliene R (2017) *Nanotoxicol* 11:996–1011
115. Adabi M, Naghibzadeh M, Adabi M, Zarrinfard MA, Esnaashari SS, Seifalian AM, Faridi-Majidi R, Aiyelabegan HT, Ghanbari H (2017) *Art Cells Nanomed Biotech* 45:833–842
116. Sharma P, Mehta M, Dhanjal DS, Kaur S, Gupta G, Singh H, Thangavelu L et al (2019) *Chemico-Biol Interact* 309:108720
117. Zhou G, Mao X, Juncker D (2012) *Anal Chem* 84:7736–7743
118. Pakdel E, Daoud WA, Afrin T, Sun L, Wang X (2015) *J Text Inst* 106(12):1348–1361
119. Wang J, Jakli A, Guan Y, Fu S, West J (2017) *Info Dis* 33(4):16–20
120. Wang J, Kolacz J, Chen Y, Jákli A, Kawalec J, Benitez M, West JL (2017) *SID symposium digest of technical papers*. 48(1):147–149
121. Mitrano DSM, Rimmele E, Wichser A, Erni R, Height M, Nowack B (2014) *ACS Nano* 8:7208–7219
122. Roy S, Dhar M, Krishna PV, May R (2013). In: Agarwal B, Jeffries B (eds). *World Wide Fund for Nature*
123. Kant R (2012). *Nat Sci* 4:22–26
124. Jabeen Siddiqui V, Rastogi S, Srivastava S, Bala S, Ahmad N, Khan T (2023) *Mater Today Chem* 33(2023):101712
125. Jabeen S, Ganie AS, Ahmad N, Hijazi S, Bala S, Bano D, Khan T (2023) *Inorg Chem Comm* 152(2023):110729