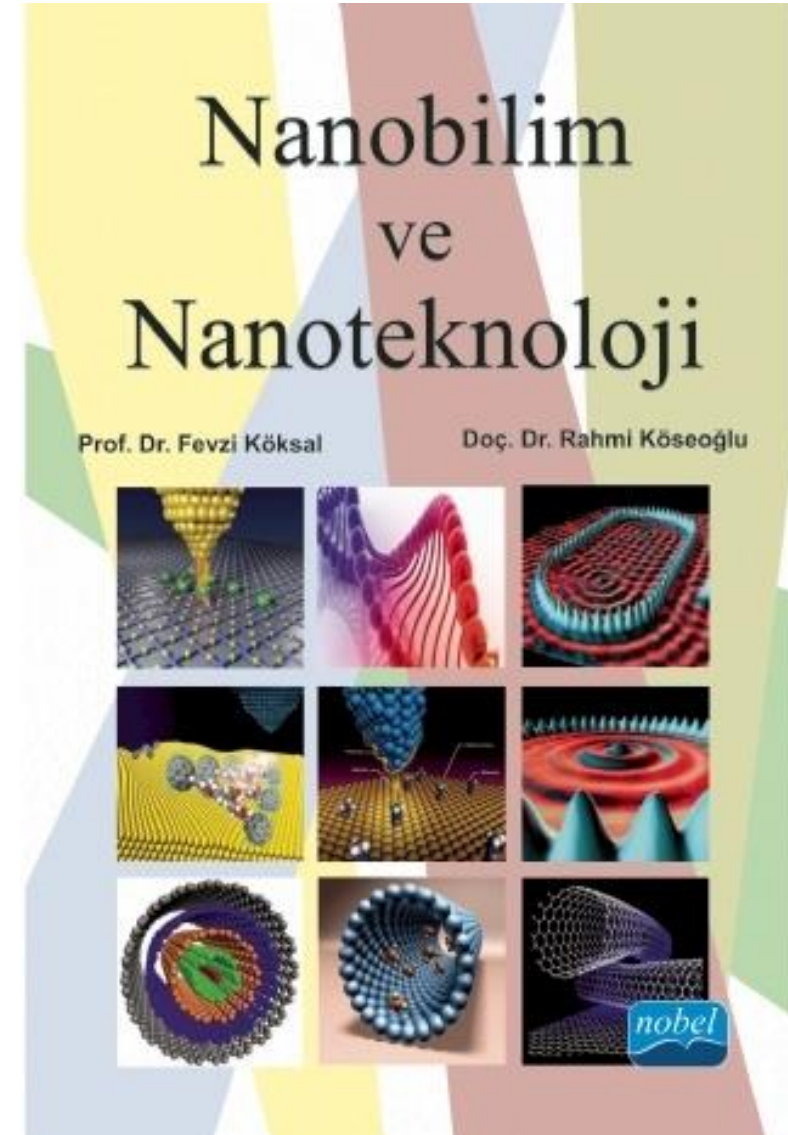
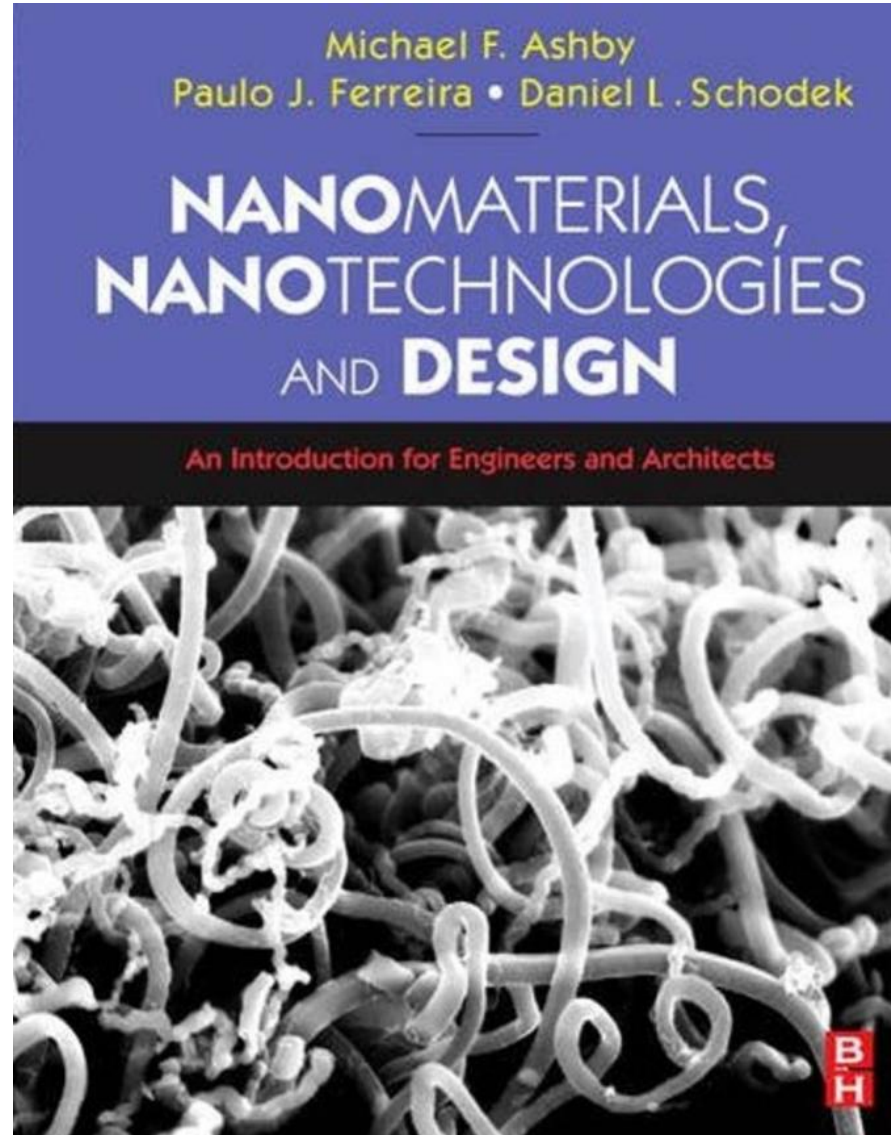
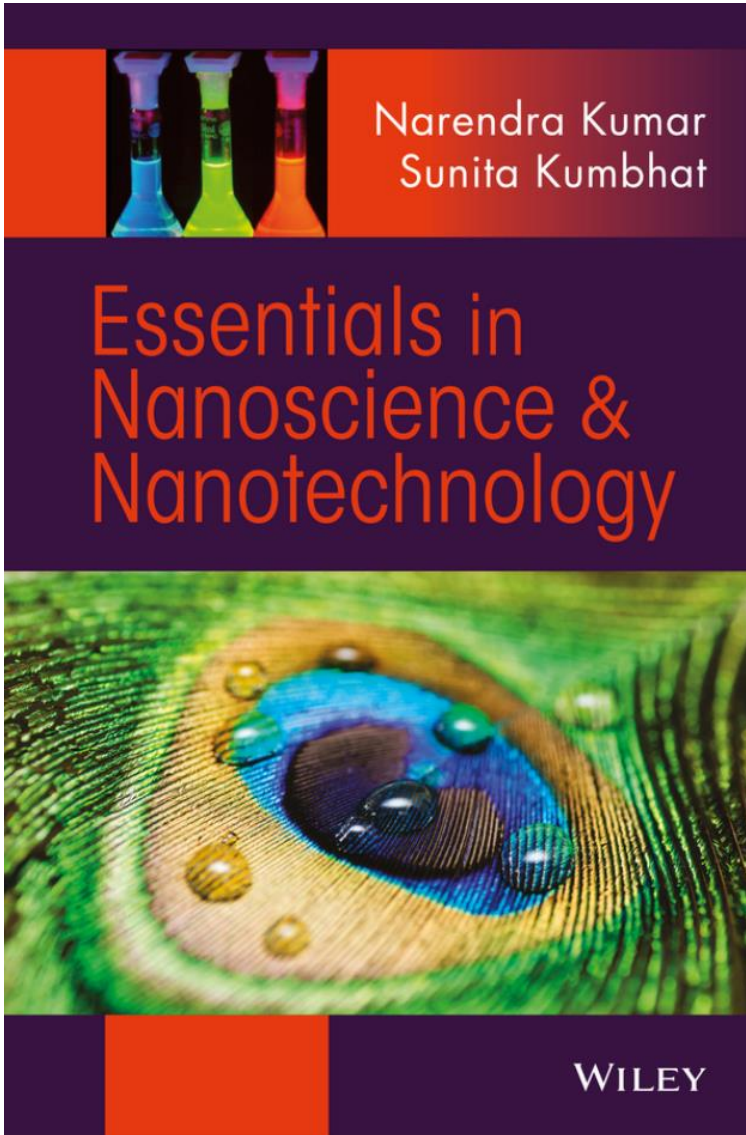




Nano Malzemeler

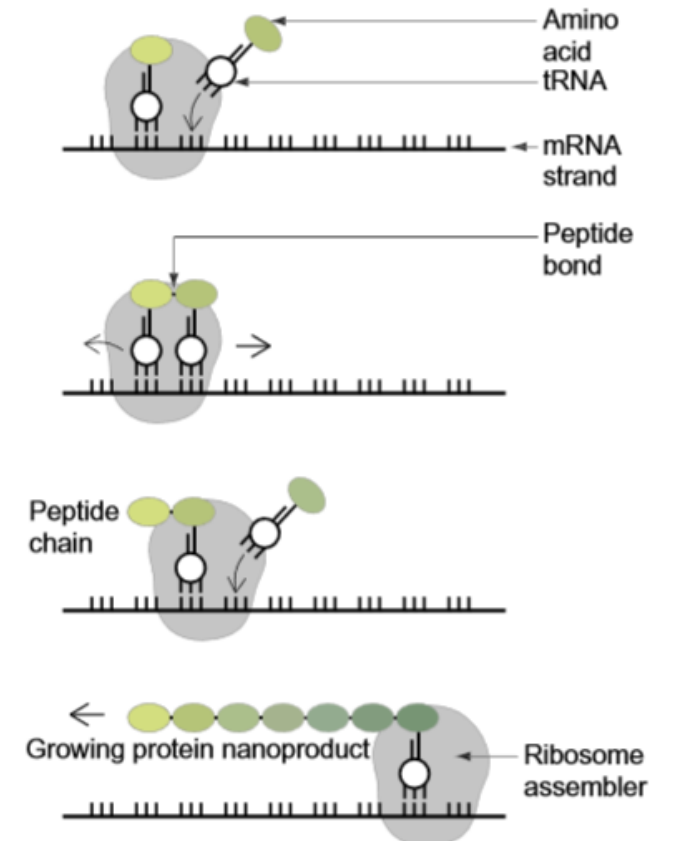
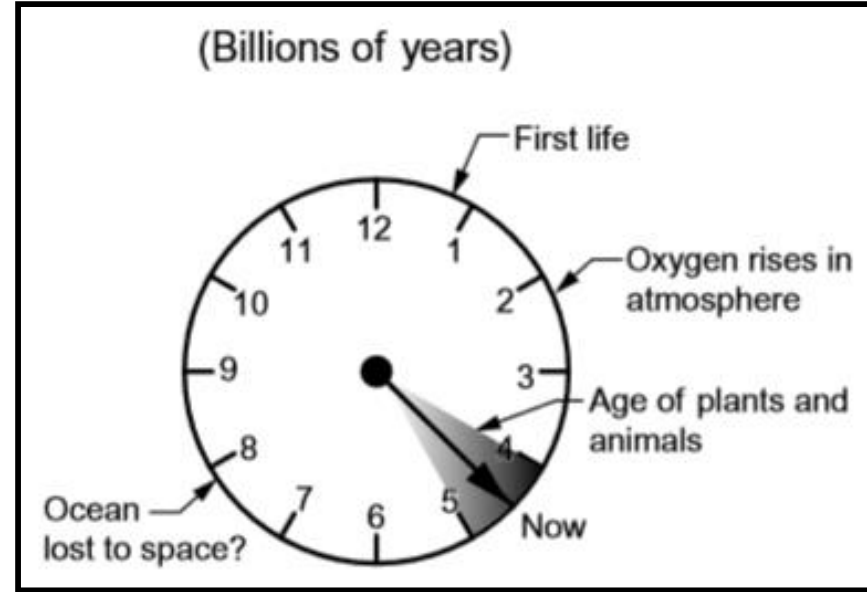
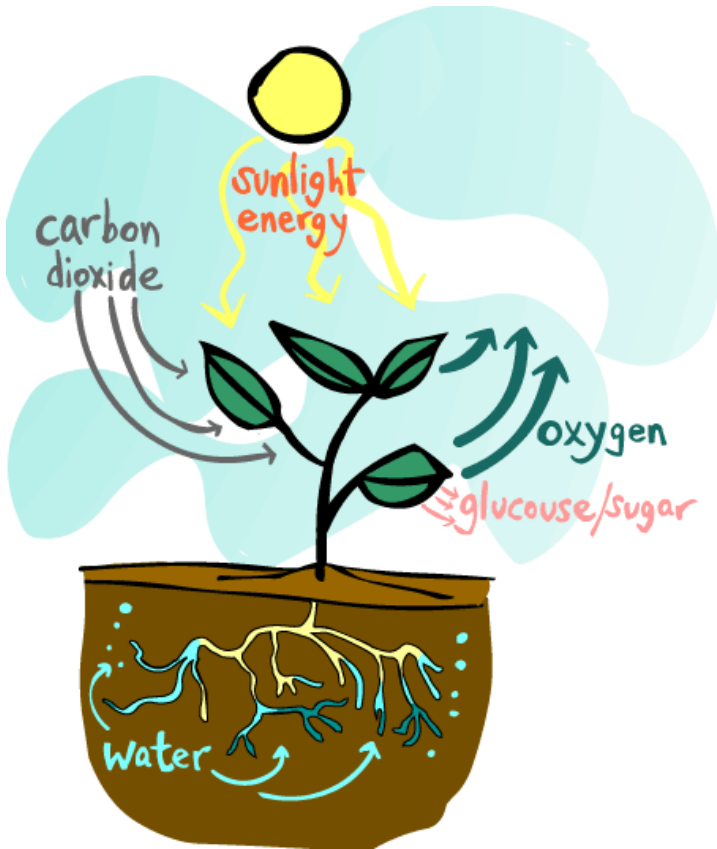
Giriş

Kaynak Kitaplar



İlk Nano Makineler

3,8 milyar Yıl Önce



Tarihçe

Yıl	Gelişme
3,8 milyar yıl	Hücre: bir nanomakine
M.Ö. 400	Demokritos'un maddenin yapı taşı olarak atomu tanımlaması
M.S. 500	Mezopotamya ve Mayalarda sır renklendiricilerin kullanılması
1840	Silica nanopartüküller
1857	Faraday'ın kararlı altın solüsyonu hazırlaması
1931	Knoll ve Ruska tarafından elektron mikroskobu geliştirilmesi
1947	İlk transistör (makro boyutlu)
1959	Richard Feynman: Plenty of rooms at the bottom
1974	Norio Taniguchi nanoteknoloji terimini kullandı
1977	Drexler moleküler nanoteknoloji konseptini ortaya attı (MIT)
1981	Binnig ve Rohrer (IBM)'in taramalı tünelleme mikroskobu
1985	Folorenin keşfi (by R. F. Curl Jr., H. W. Kroto, R. E. Smelly)
1986	Binnig, Quate ve Gerber (IBM)'in atomik kuvvet mikroskobu
1986	Eric Drexler: Engines of Creation: The Coming Era of Nanotechnology, ilk kitap.
1991	Carbon nanotüpün icadı (by S. Iijima)
1998	Carbon nanotüp transistör (by C. Dekkar and coworkers)
2000	Stimulated emission depletion (STED) mikroskobu by S. Hell
2001	Moor kanunu aşan en hızlı transistör (1,5 milyon/s)
2004	Grafenin icadı (by A. Giem and K. Novoselov)
2006	Single-molecule microscopy (SMM) icadı (by E. Betzig)



Figure 1.8 (a) Lycurgus cups. Courtesy of Trustees of the British Museum. © The Trustees of the British Museum; (b) ancient Maya fresco painting. Reproduced from Sanchez et al. [8] © 2005. With permission of The Royal Society of Chemistry. (See color plate section for the color representation of this figure.)

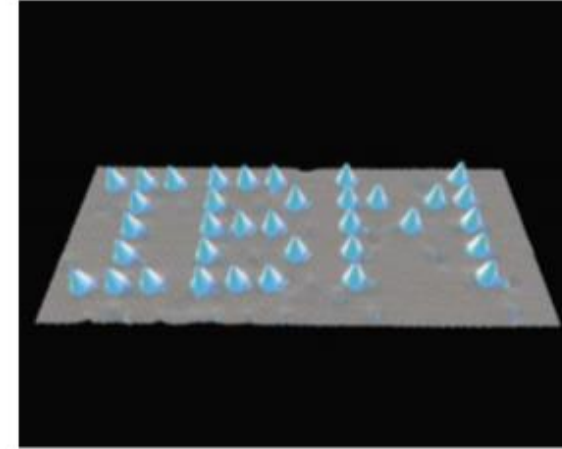


FIGURE 1.7 Xenon atoms arranged on a Ni substrate by a scanning tunneling probe, forming the word IBM. (Courtesy of IBM.)

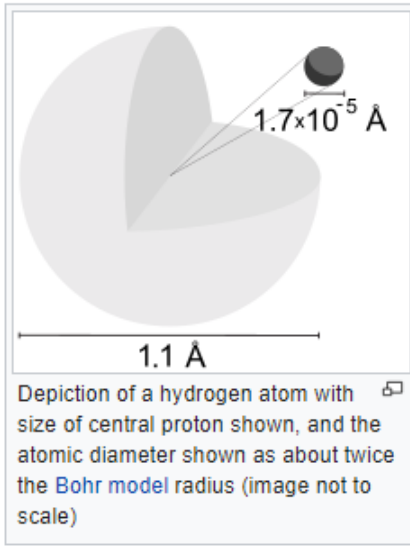


FIGURE 1.3 Microcar produced by Nippondenso Co. The latest model has a micromotor 1 mm in diameter. With power supplied by a 25 micron copper wire, the car runs smoothly at a speed of about 1 cm/s with 3 V voltage and 20 mA current. (Courtesy of Nippondenso.) **1994**

Temel Kavramlar

Nanobilim: Nanomalzemelerin eşsiz özellikleri ile ilgilenen disiplin. Nanobilim, çeşitli cisim/partiküllerin 1-100 nm arasında değişen çok küçük boyutlarda ortaya çıkan özellikleri ile ilgilenir.

Nano, metrik sistemde bir birimdir ve $1 \text{ nm} = 10^{-9} \text{ m}$ 'dir.



10 tane hidrojen atomu 1 nm

Temel Kavramlar

Nanomalzeme: Yaygın tanıma göre en az bir boyutu 100 nm'den küçük olan ya da bu küçük malzemelerin bir araya gelmesiyle oluşan malzemelere nanomalzemeler denir. Sağlık, çevre gibi bazı alanlarda bu aralık 0.3 nm ile 300 nm arasında olarak değişiklik gösterebilmektedir.

Nanoteknoloji: En az bir boyutu nanomalzeme boyut sınırları içerisinde kalan atomik ve moleküler fonksiyonel yapıları kullanarak çeşitli cihazların/aletlerin yapımına nanoteknoloji denir.

Boyut kaynaklı karakterleri, özgün ve oldukça önemli fiziksel, kimyasal, biyolojik, olgu ve işlemler sergilemelerine neden olmaktadır.

Yani, nanoteknoloji, malzemelerin atomik, moleküler ve supramoleküler seviyelerde ölçümü ve manipülasyonunu içeren araştırma/geliştirme faaliyetleridir.

Boyutlar

THE SCALE OF THINGS

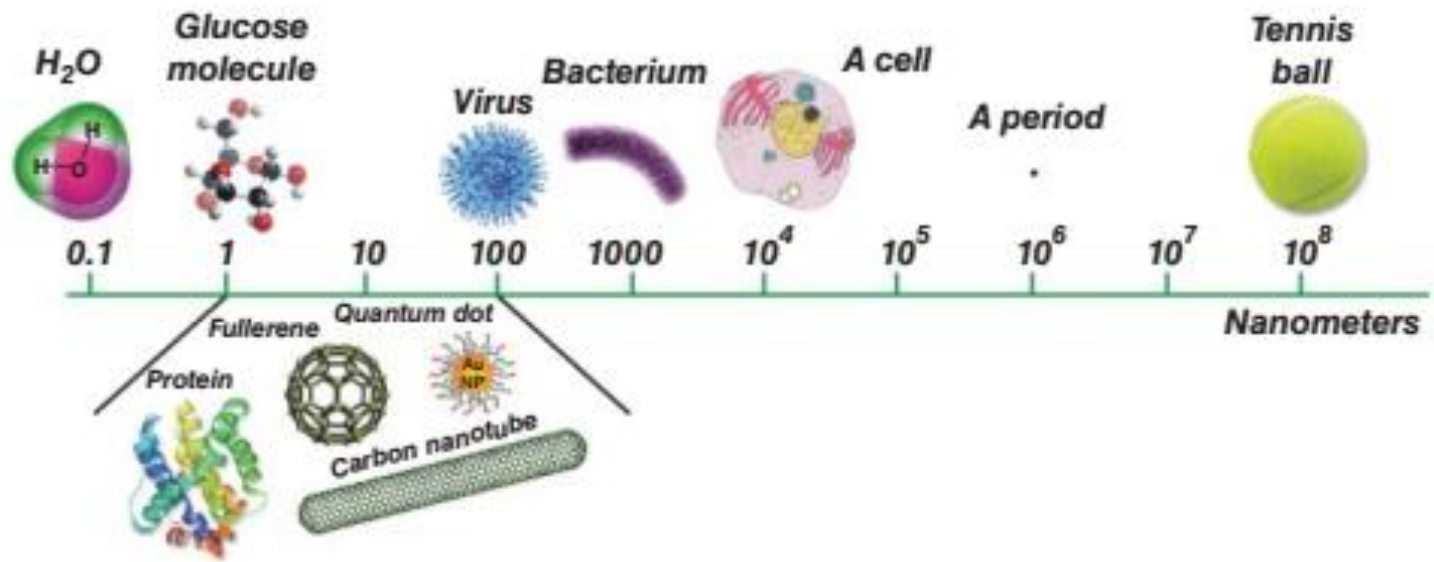
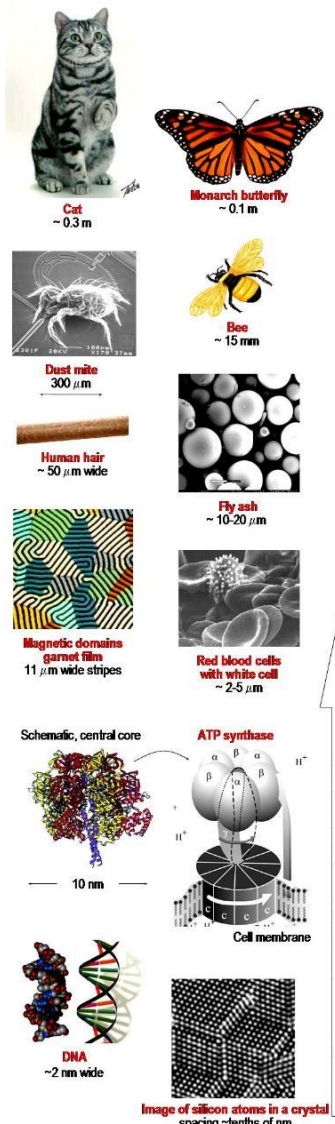
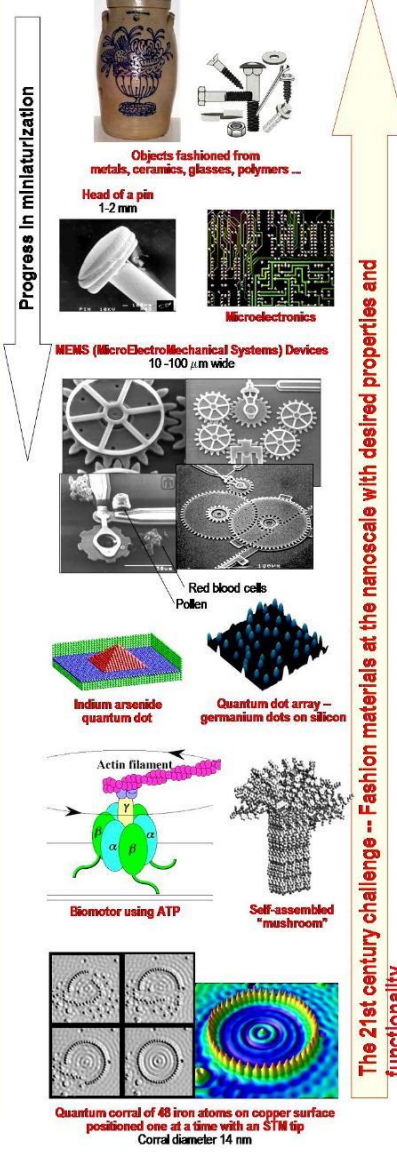


Figure 1.1 Size comparisons of objects, nanomaterials, and biomolecules.

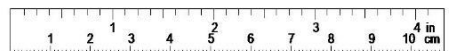
Things Natural



Things Manmade



meter	m	10 ⁰	1 m
centimeter	cm	10 ⁻²	0.01 m
millimeter	mm	10 ⁻³	0.001 m
micrometer	μm	10 ⁻⁶	0.000001 m
nanometer	nm	10 ⁻⁹	0.000000001 m



The 21st century challenge -- Fashion materials at the nanoscale with desired properties and functionality

Boyutlar

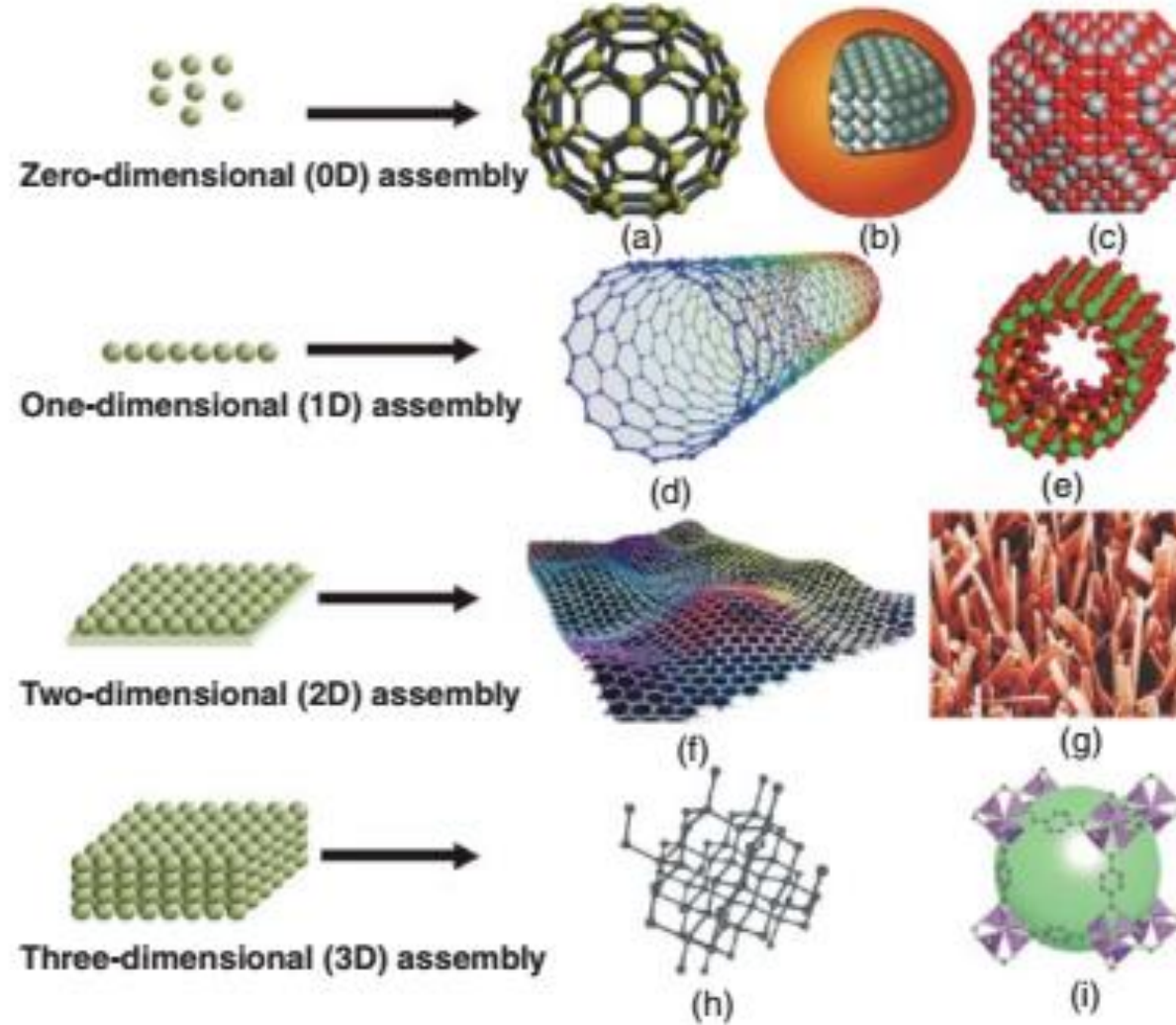
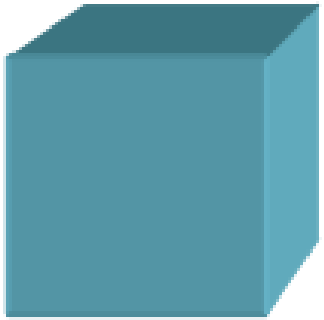


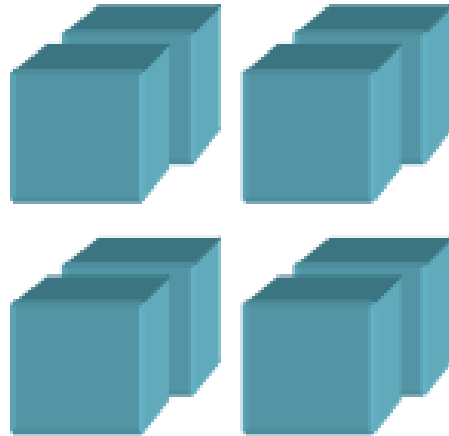
Figure 1.10 Typical examples showing varied dimensionality in nanomaterials: (a) fullerene; (b) quantum dot; (c) metal cluster; (d) carbon nanotube; (e) metal oxide nanotube; (f) graphene; (g) metal oxide nanobelts; (h) nanodiamond; (i) metal organic frameworks (MOFs).

Boyut-Yüzey

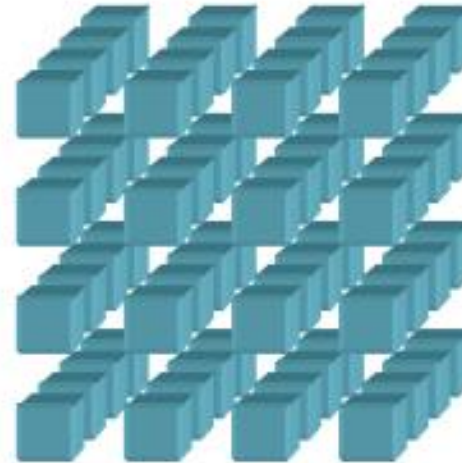
Volume 1 cm^3
Area 6 cm^2
Side 1 cm



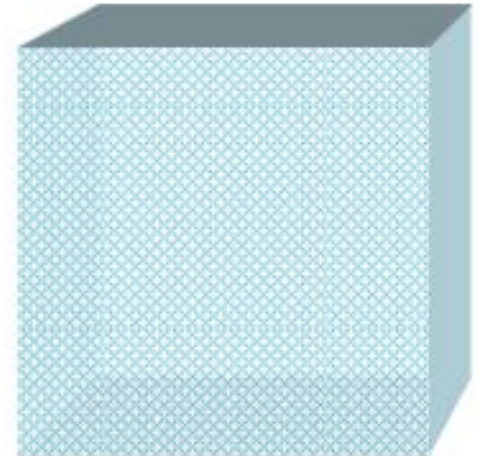
Volume 1 cm^3
Area 12 cm^2
Side $\frac{1}{2} \text{ cm}$



Volume 1 cm^3
Area 24 cm^2
Side $\frac{1}{4} \text{ cm}$



Volume 1 cm^3
Area $60,000,000 \text{ cm}^2$
Side 1 nm



Boyut-Yüzey

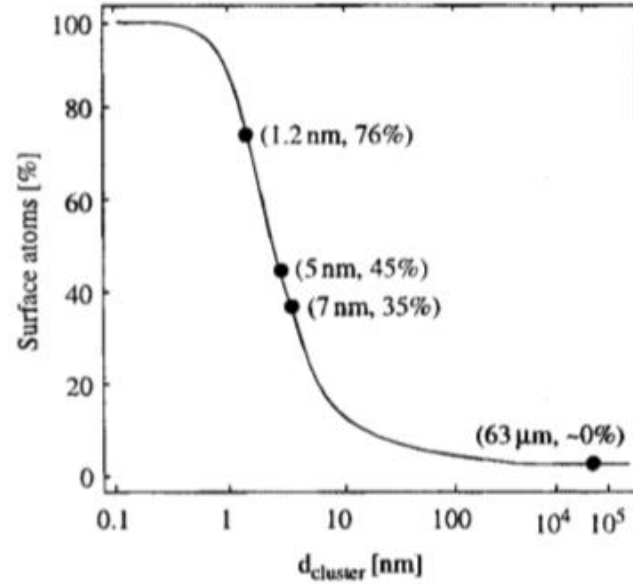


Fig. 2.1. The percentage of surface atoms changes with the palladium cluster diameter. [C. Nützenadel, A. Züttel, D. Chartouni, G. Schmid, and L. Schlapbach, *Eur. Phys. J. D8*, 245 (2000).]

Table 2.1. Variation of surface energy with particle size.²²

Side (cm)	Total surface area (cm ²)	Total edge (cm)	Surface energy (J/g)	Edge energy (J/g)
0.77	3.6	9.3	7.2×10^{-5}	2.8×10^{-12}
0.1	28	550	5.6×10^{-4}	1.7×10^{-10}
0.01	280	5.5×10^4	5.6×10^{-3}	1.7×10^{-8}
0.001	2.8×10^3	5.5×10^6	5.6×10^{-2}	1.7×10^{-6}
10^{-4} (1 μm)	2.8×10^4	5.5×10^8	0.56	1.7×10^{-4}
10^{-7} (1 nm)	2.8×10^7	5.5×10^{14}	560	170

Kenar uzunluğu 1 cm



Yüzey atomları oranı % 0,00001

Kenar uzunluğu 10 nm



Yüzey atomları oranı % 10

Kenar uzunluğu 1 nm



Hepsi yüzey atomu

Boyut Etkisi

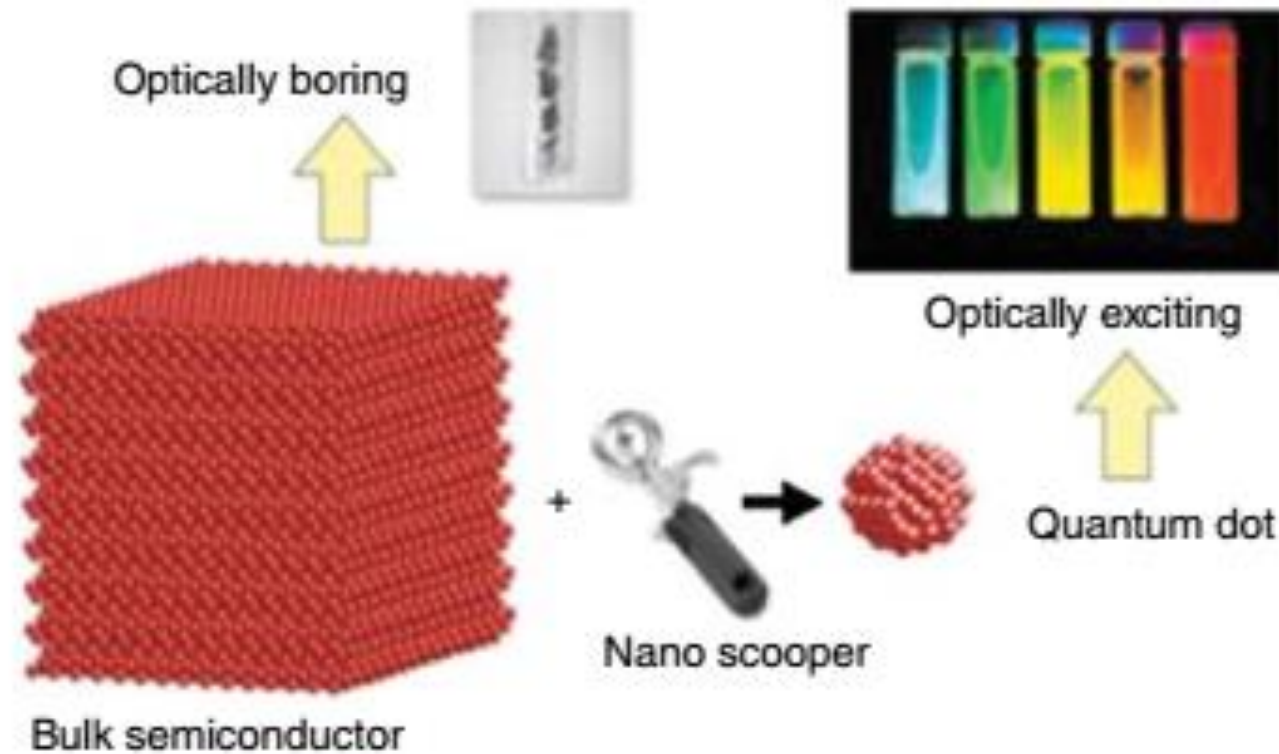


Figure 1.3 Change in optical properties of a semiconductor ranging from bulk to nanosize. Courtesy of Grossman, MIT, USA. (See color plate section for the color representation of this figure.)

Boyut Etkisi

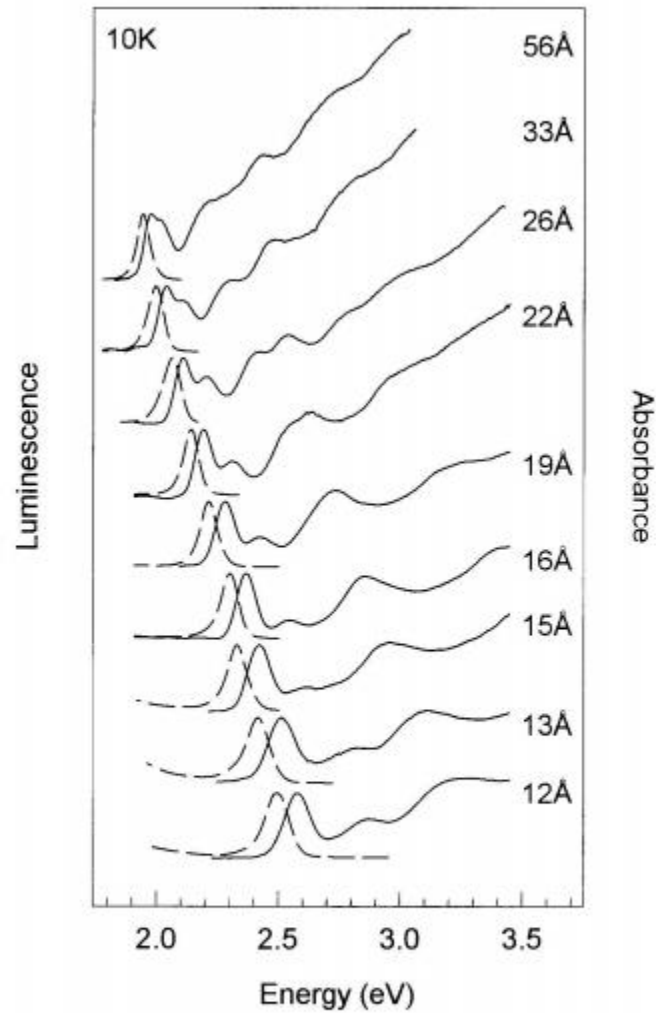


Figure 1.4: Size dependent absorption and emission spectra of colloidal CdSe quantum dots.



Figure 1.2: Photograph of the size dependent emission spectra of both HgS (top) and CdSe (bottom) quantum dots. Small quantum dots absorb and emit blue/green light, larger dots absorb and emit red light.

Nanomateriallerin Karakteristikleri ve Önemi

TABLE 1.3 Characteristics of Nanomaterial and Their Importance

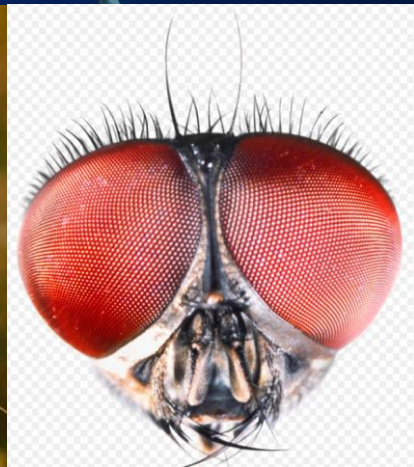
Characteristic	Importance
Size	Key defining criteria for a nanomaterial
Shape	Carbon nanosheets with a flat geodesic (hexagonal) structure show improved performance in epoxy composites versus carbon fiber
Surface charge	Surface charge is as important as size or shape. Can impact adhesion to surfaces and agglomeration characteristics. Nanoparticles are often coated or “capped” with agents such as polymers (PEG) or surfactants to manage the surface charge issues
Surface area	This is a critical parameter as the surface-to-weight ratio for nanomaterials is huge. For example, 1 g of an 8-nm-diameter nanoparticle has a surface area of 32 m ²
Surface porosity	Nanoparticles may have occlusions and cavities on the surface Many nanomaterials are characterized with zeolite-type porous surfaces. These engineered surfaces are designed for maximum absorption of a specific coating or to accommodate other molecules with a specific size
Composition	The chemical composition of nanomaterials is critical to ensure the correct stoichiometry being achieved. The purity of nanomaterials, impact of different catalysts used in the synthesis, and presence of possible contaminants need to be assessed along with possible coatings that may have been applied
Structure	Knowledge of the structure at the nanolevel is important. Many nanomaterials are heterogeneous, and information concerning crystal structure and grain boundaries is required

Source: Courtesy of PerkinElmer, Inc.

Doğadaki Nanobilim

TABLE 1.1 Bio-Inspired Unique Properties

Natural System/Materials	Bio-Inspired Properties
Substructure of nacre	Low-density, high-strength composites
Spider silk	High-tensile strength fiber
Wood, ligaments, and bone	High-strength structural material
Eels and nervous system	Electrical conduction
Deep-sea fish and glow worms	Photoemission
Butterfly and bird wings	Photonic crystals
Moth eye	Antireflective
Lotus leaf, human skin, fish scales	Hydrophobic surfaces, self-cleaning
Shark skin	Drag reducing
Gecko's feet	Adhesion
Human brain	Artificial intelligence and computing



Doğadaki Nanobilim

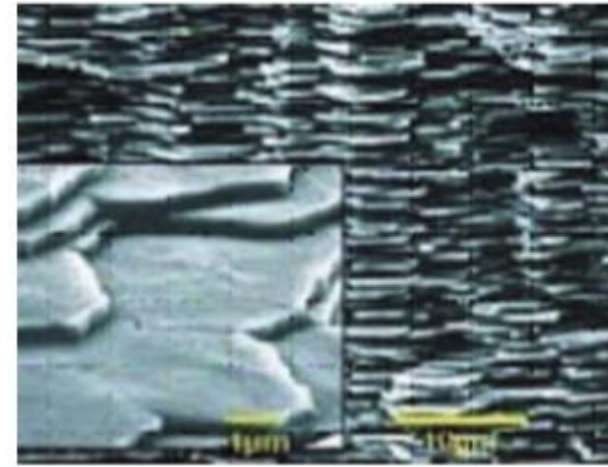
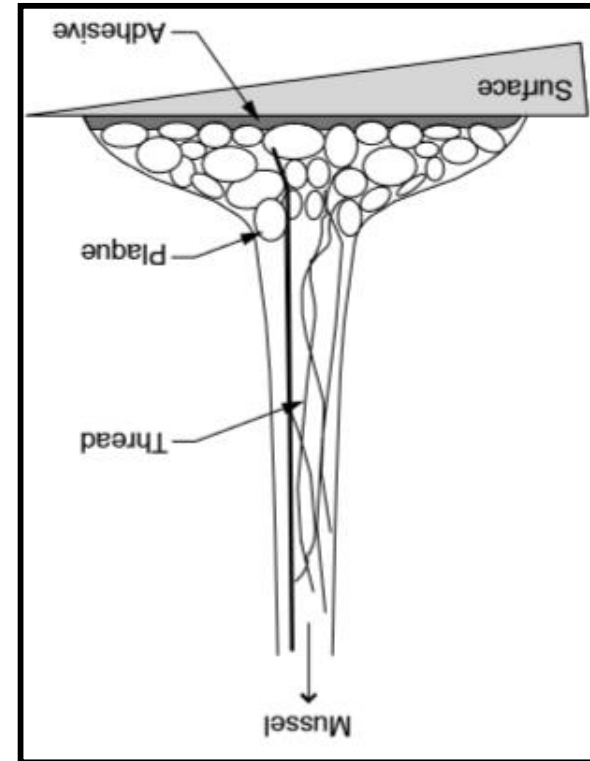
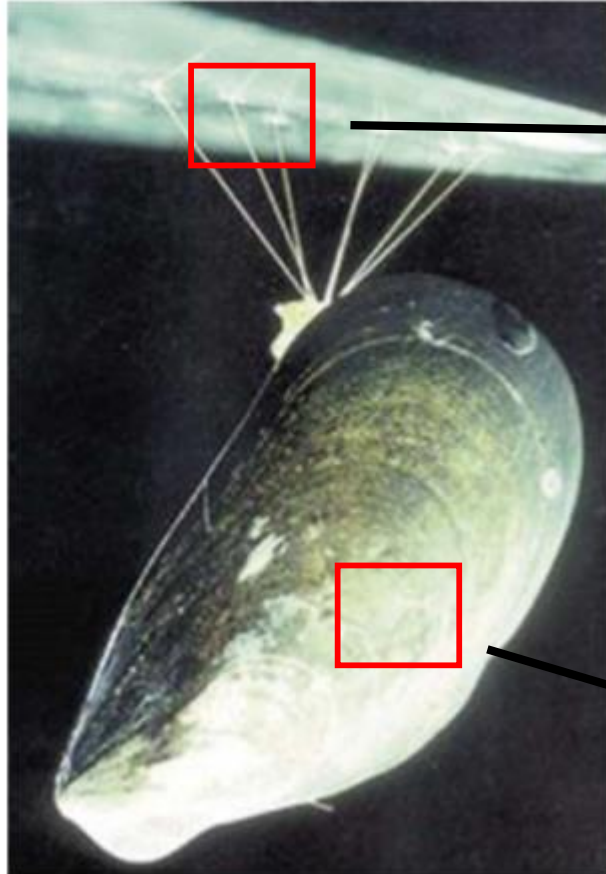


FIGURE 2.7

Mussel anchored to a surface by filaments called byssus. (Courtesy of Mieke C. van der Leeden, TU Delft.)

Doğadaki Nanobilim

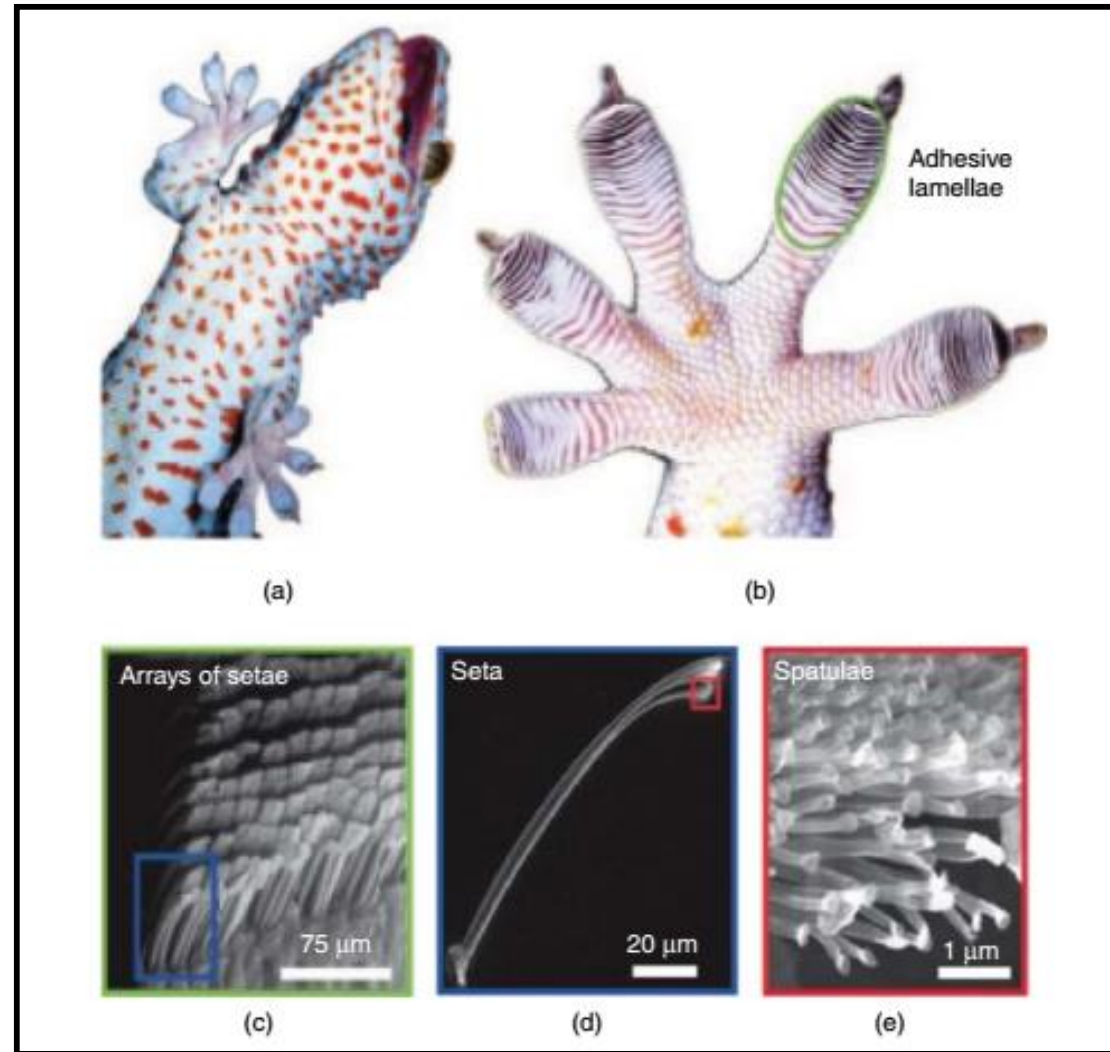


Figure 1.7 Gecko's adhesive system structure: (a) ventral view of a tokay gecko (*Gekko gecko*); (b) sole of the foot showing adhesive lamellae; (c) microstructure: part of a single lamella showing arrays of setae; (d and e) nanostructure: single seta with branched structure at the upper right area, terminating in hundreds of spatular tips. Hansen and Autumn [6], © 2005. With permission of National Academy of Sciences, USA. (See color plate section for the color representation of this figure.)

Doğadaki Nanobilim

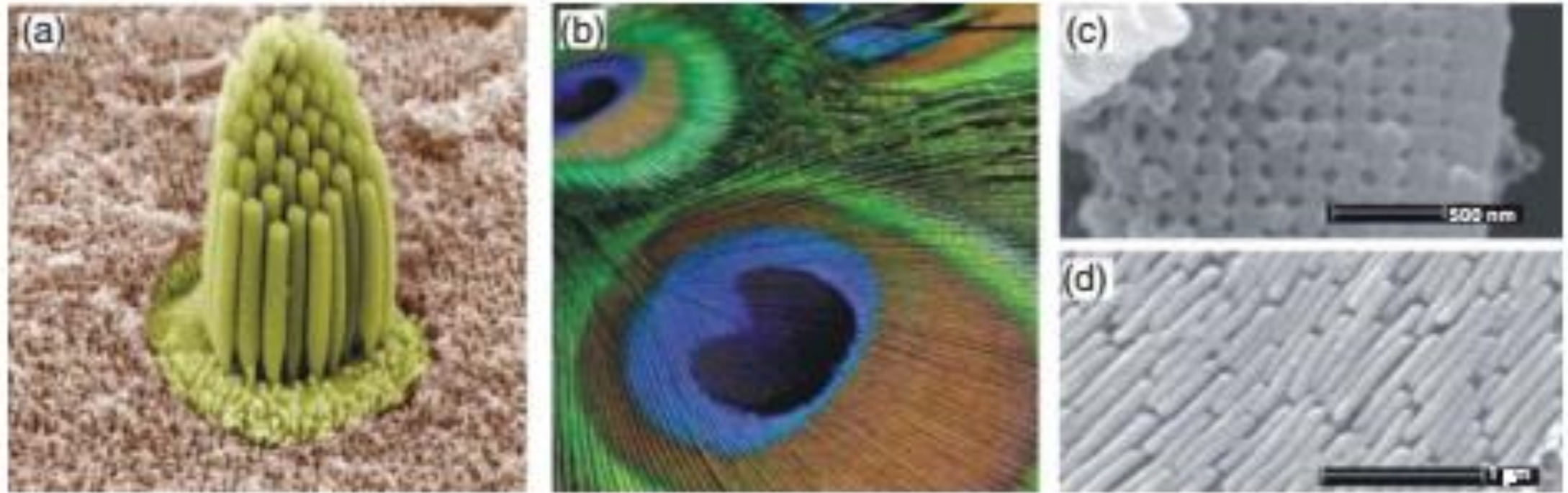


Figure 1.4 Nanotechnology in nature: (a) electron microscopic image of a sensory patch in amphibian ears. <http://scinerds.tumblr.com/post/35542105310/stereocilia-stairsteps>; (b) peacock feather showing barbules, representing a photonic lattice; (c and d) electron microscopy image of transverse and longitudinal sections of barbules. Zi et al. [2a] © 2003. With permission of National Academy of Sciences, USA. (See color plate section for the color representation of this figure.)

Doğadaki Nanobilim

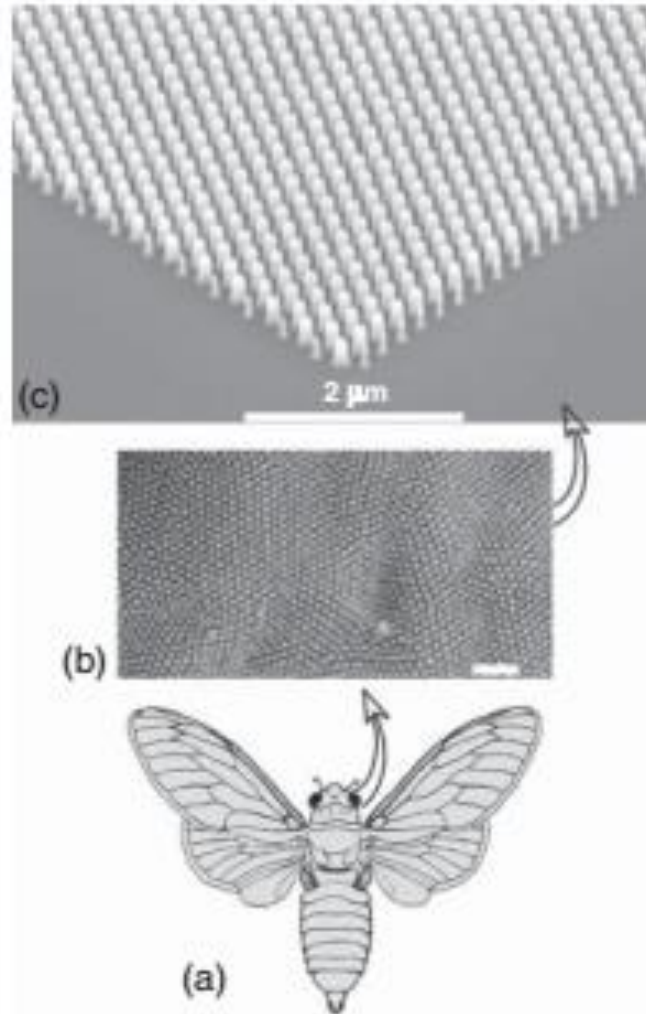


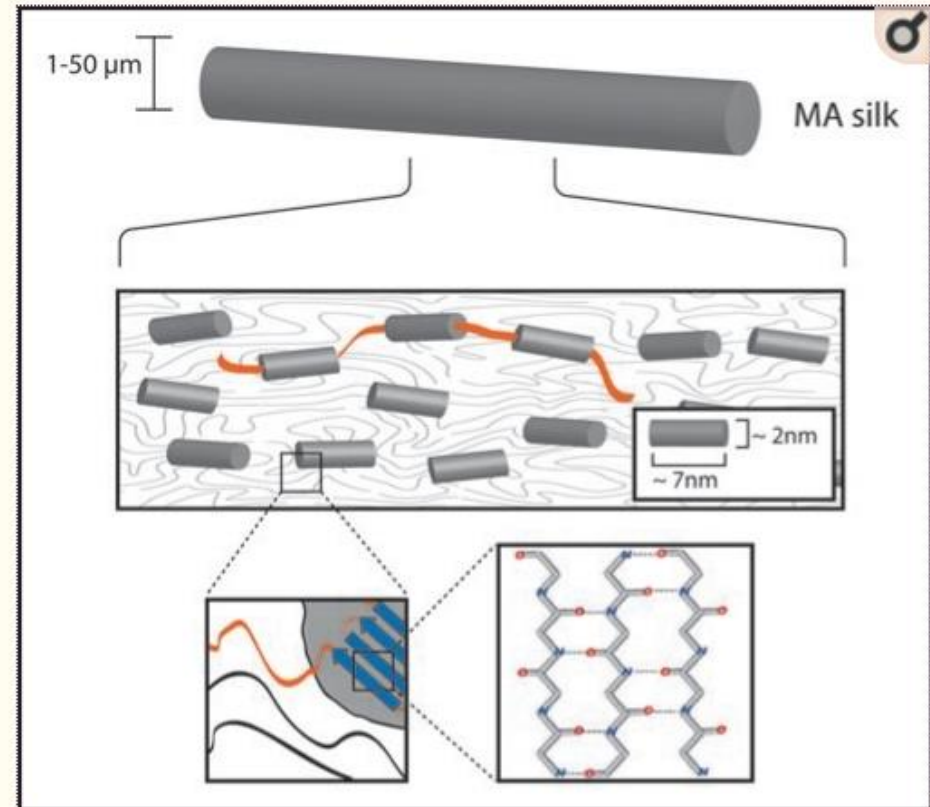
Figure 1.5 Natural and fabricated antireflective surfaces: (a) schematic of a moth; (b) scanning electron micrograph of antireflective surface of a moth's eye (scale bar = 1 μm); (c) biomimetic replica of a moth eye fabricated with ion-beam etching. Parker & Townley [2c] © 2007. With permission of Nature Publishing Group.

Doğadaki Nanobilim



FIGURE 2.10

Spider web.



Schematic structure of spider MA silk. The thread is composed of small crystalline b-sheet rich subunits (see close-ups) which are embedded into an amorphous structure. The crystalline and noncrystalline parts are covalently connected, ensuring the coexistence of strength and ductility. Diameters of MA threads depend on species, but also on age, weight and state of health of a specific individual.

Doğadaki Nanobilim

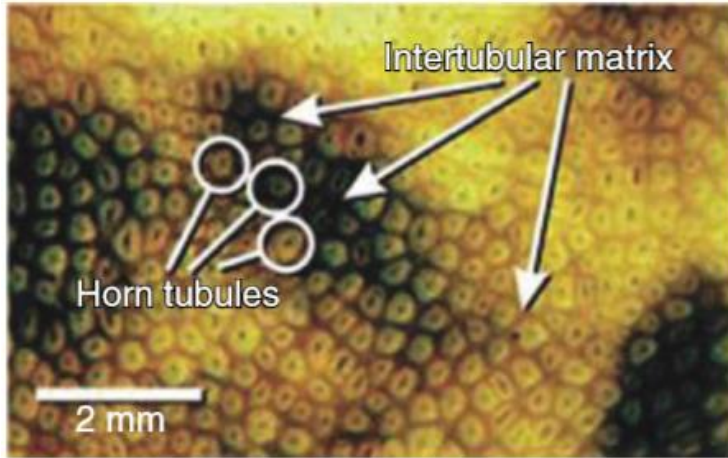


FIGURE 2.11

Microstructure of a white rhinoceros horn. The horn tubules, surrounded by the intertubular matrix, act as a composite material. (Courtesy of Tobin Hieronymus et al., Ohio University.)

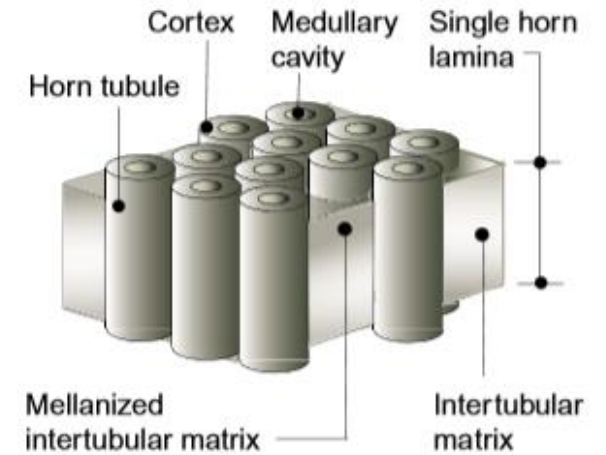
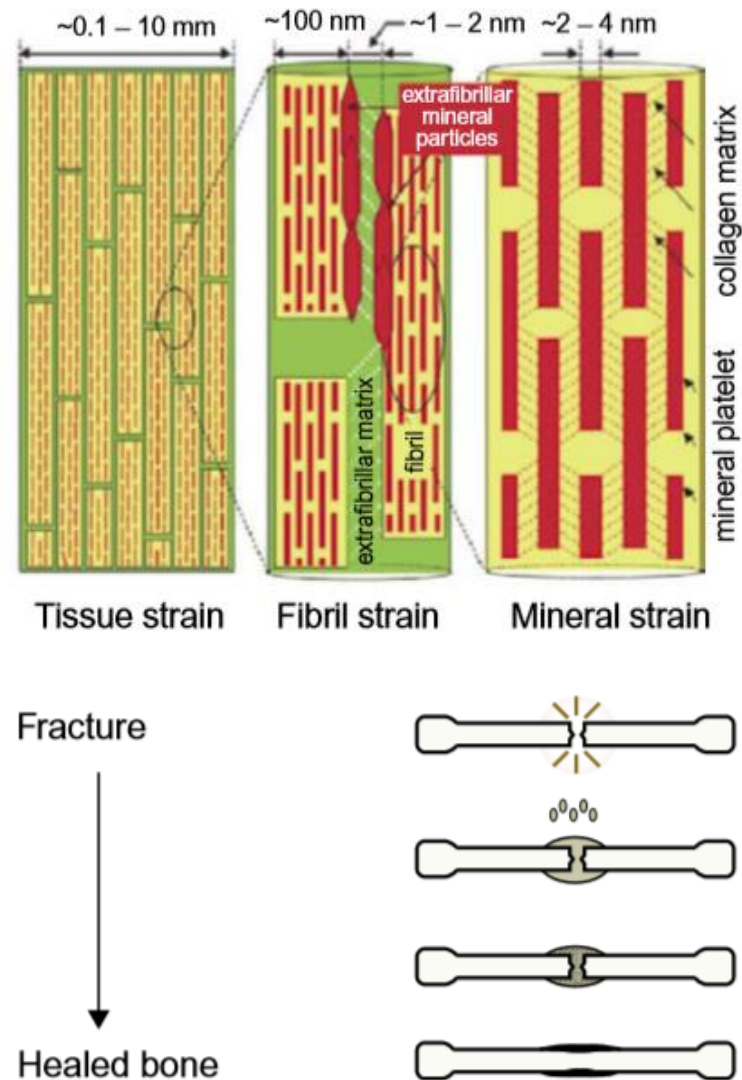


FIGURE 2.12

Schematic three-dimensional view of a white rhinoceros horn, where the various components of the composite material forming one horn lamina are indicated. Each horn tubule is composed of the cortex and medullary cavity, which is surrounded by melanized and non-melanized intertubular matrix. (Courtesy of Tobin Hieronymus et al. Ohio University.)

Doğadaki Nanobilim



Kendi kendini onaran malzemeler

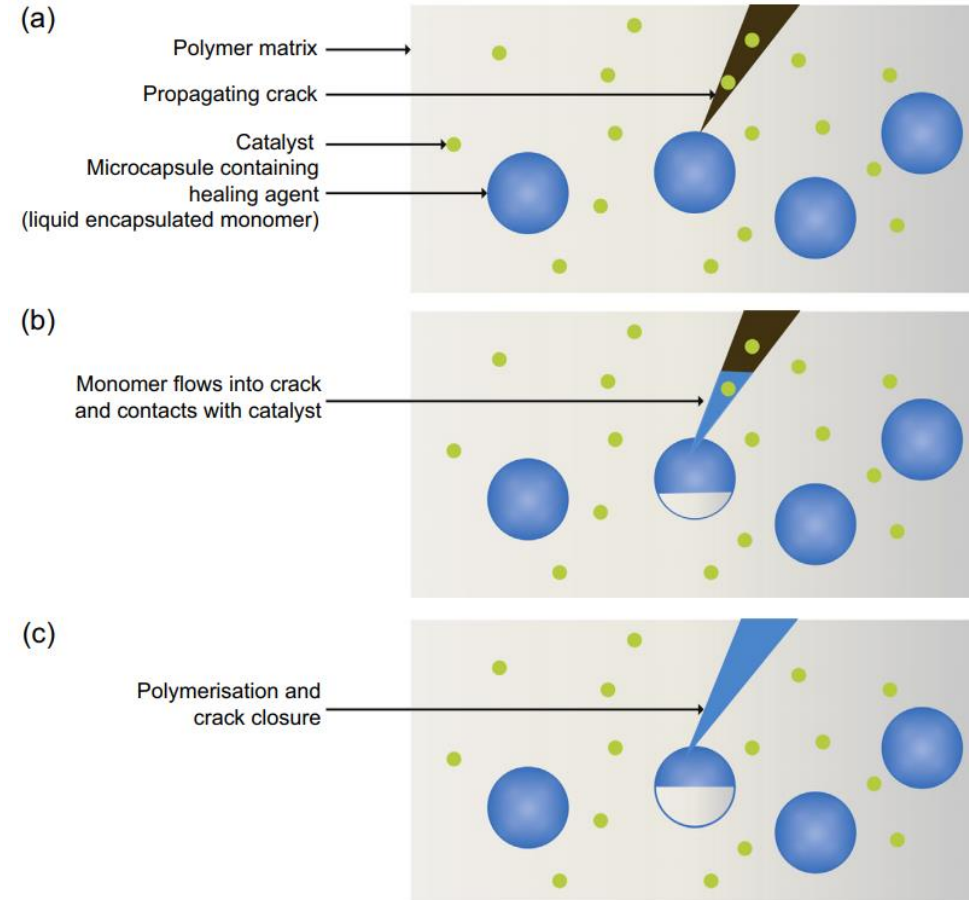


Figure 4.1 Self-healing process based on the incorporation of microcapsules. (a) Crack propagation up to healing agent capsule, (b) monomer flow, (c) crack healing by polymerization.

Doğadaki Nanobilim

Kendi Kendini Onaran Malzemeler



Doğadaki Nanobilim

Lotus Etkisi

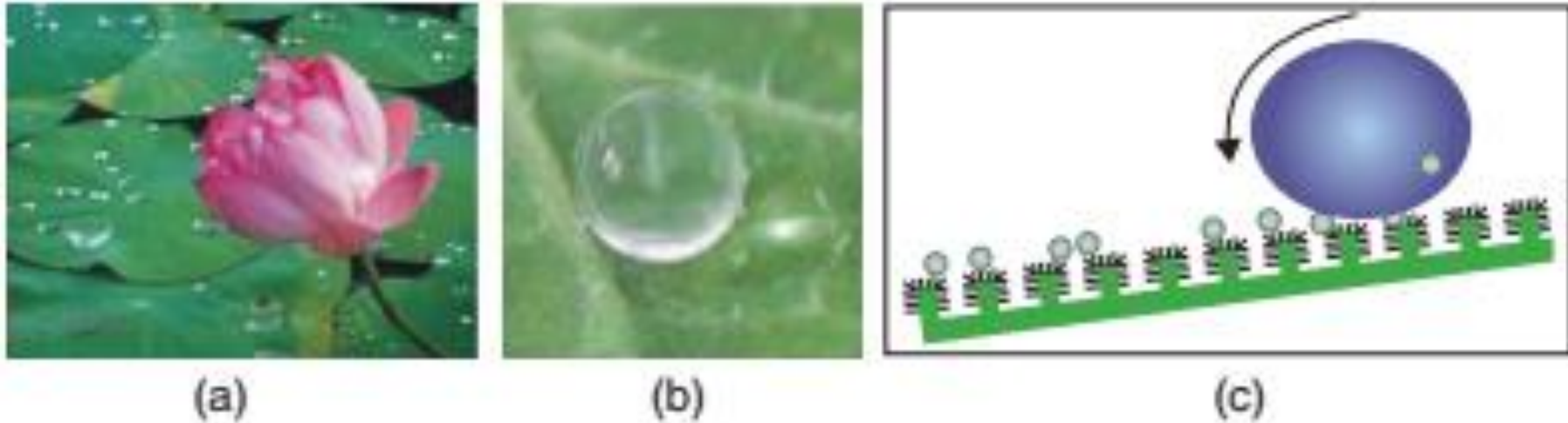
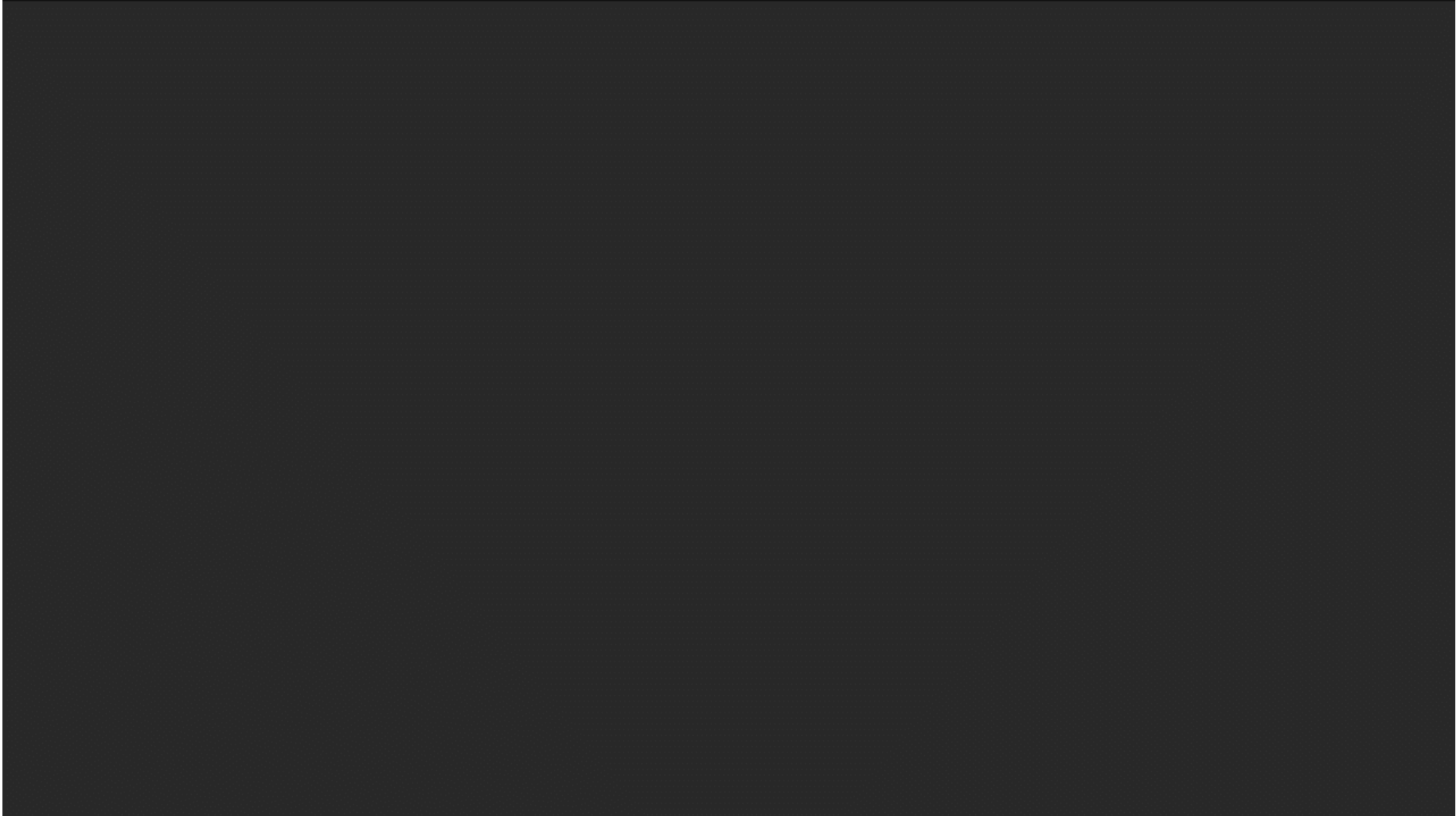


Figure 1.6 (a) Lotus (*Nelumbo nucifera*) plant; (b) spherical water droplet on a nonwettable lotus plant leaf. Blossey [6] © 2003. With permission of Nature Publishing Group. ; (c) self-cleaning: a drop picks up the dirt particles as it rolls off the leaf's surface.

Doğadaki Nanobilim

Lotus Etkisi



Ticari Uygulamaları

TABLE 1.5 Summary of Some Commercialized Nano-Based Products and Their Specific Applications

Broad Area	Type of Nanomaterials	Specific Application
Environmental protection	Nano zerovalent iron (nZVI)	Remediation of ground and surface waters exposed to chlorinated hydrocarbons
	Nano ZnO, TiO ₂ , CeO ₂	Protection from UV radiations to preserve wood, concrete, and metal surfaces
Food technology	Nano clay	Packaging material to enhance shelf life of food
Energy: conversion, storage, and distribution	Pd- and V-doped carbon nanotubes	More efficient fuel cells by increasing storage capacities and faster hydrogen absorption kinetics
Healthcare	NPs of gold, silver, magnetic oxides, polymers	To achieve better resolution and contrast in MRI and CT-based imaging for diagnosis, therapy and targeted drug delivery
Textiles	Silver nanoparticles	Integrated in dressing and clothing to prevent microbial growth and odor
	Nano TiO ₂	Self-cleaning and wrinkle-free clothing
Cosmetics	Nano TiO ₂ and nano ZnO	Soaps, sun screen lotion, moisturizers
Defense	CNTs, graphene, metal nano-oxides, nanocomposites	Ballistic protection, kinetic energy penetration, stealth technology
Aerospace	Clay nanoparticles	Fire retardant aircraft interiors
Automotive	CeO ₂ NPs	As catalyst to enhance combustion in diesel fuel
Sports equipments	CNTs, carbon nanofiber, nanocomposites	Stronger and flexible golf shafts, tennis racket, racing bicycle components

Potansiyel Saęlık ve Çevre Riskleri

