Nano Malzemeler
Uygulama Alanları

Nanomalzemelerin Uygulama Alanları

Tıp: Tanılama yöntemleri, ilaç tasarımı ve ilaç salınımı, doku ve biyomalzeme mühendisliği, kanser tedavisi

Bilişim ve bilgisayar teknolojileri: Entegre devreler, data saklama (hafıza/harddisk), görüntüleme

Nanoelektromekanik sistemler (NEMS): Sensörler, devreler, navigasyon

Çevresel uygulamalar: Su arıtımı, hava kirliliği kontrolü

Enerji: Fotovoltaik güneş enerji uygulamaları, yapay fotosentez, termoelektrik uygulamalar, piezoelektrik, hidrojen üretimi ve saklanması, piller

Kimyasal ve biyolojik sensörler: Yapay burun, refraktif indeks sensörü

Savunma sanayii: Hafif askeri platformlar, kamuflaj malzemeleri.

Genel tüketim malzemeleri: Kozmetik, gıda, tekstil, kendi kendini temizleyen yüzeyler, spor ekipmanları

Tıp ve Sağlık

Biyolojik sistemlerin gözlemlenmesi, tamir edilmesi, yapımı ve kontrolünde kullanılan nanoaletler, hedeflenmiş ilaç salınımı, zarar görmüş sistemlerin değişimi (kanserli hücre, kan damarı, deri, kemik vb).

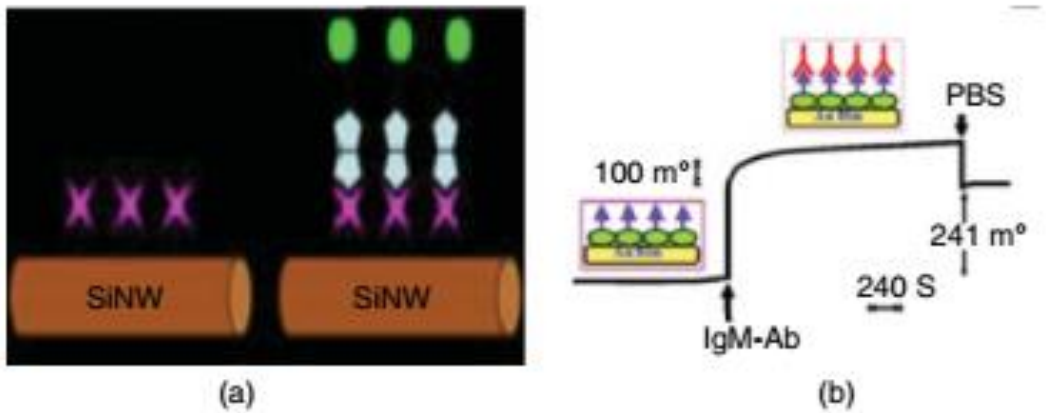
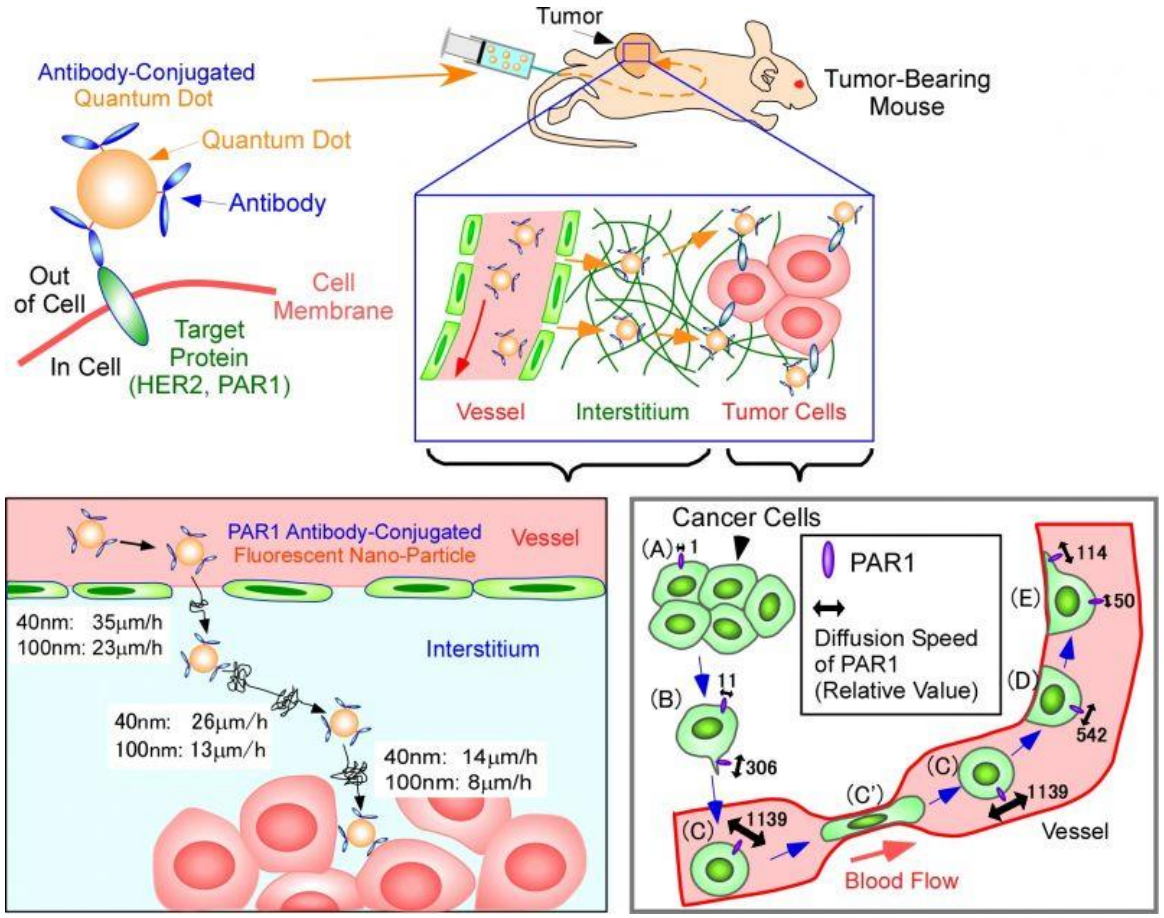


Figure 9.1 Nanobiosensor. (a) Silicon nanowires surface modifie with avidin molecules (purple stars), which selectively bind a streptavidin-functionalized molecule or nanoparticle. Courtesy of Raj Mohanty, Boston University, USA. (b) Nano-gold surface immobilized with dengue antigen–BSA conjugate for detection of dengue using SPR technique. Kumbhat et al. [4], ©2010. With permission of Elsevier. (*See color plate section for the color representation of this figure.*)

- Biyosensörler, kimyasal değişimi renk, rezonans, akım, şiddet gibi sinyallere dönüştürür.
- Biyosensörler, optiksensörler, elektrokimyasal biyosensörler, kütle-hassasiyetli biyosensörler veya termal biyosensörler olarak sınıflandırılırlar.
- Kuantom dotlar (QD), metalik silika, manyetik, fulleren…

Tıp ve Sağlık

Biyolojik sistemlerin gözlemlenmesi, tamir edilmesi, yapımı ve kontrolünde kullanılan nanoaletler, hedeflenmiş ilaç salınımı, zarar görmüş sistemlerin değişimi (kanserli hücre, kan damarı, deri, kemik vb).



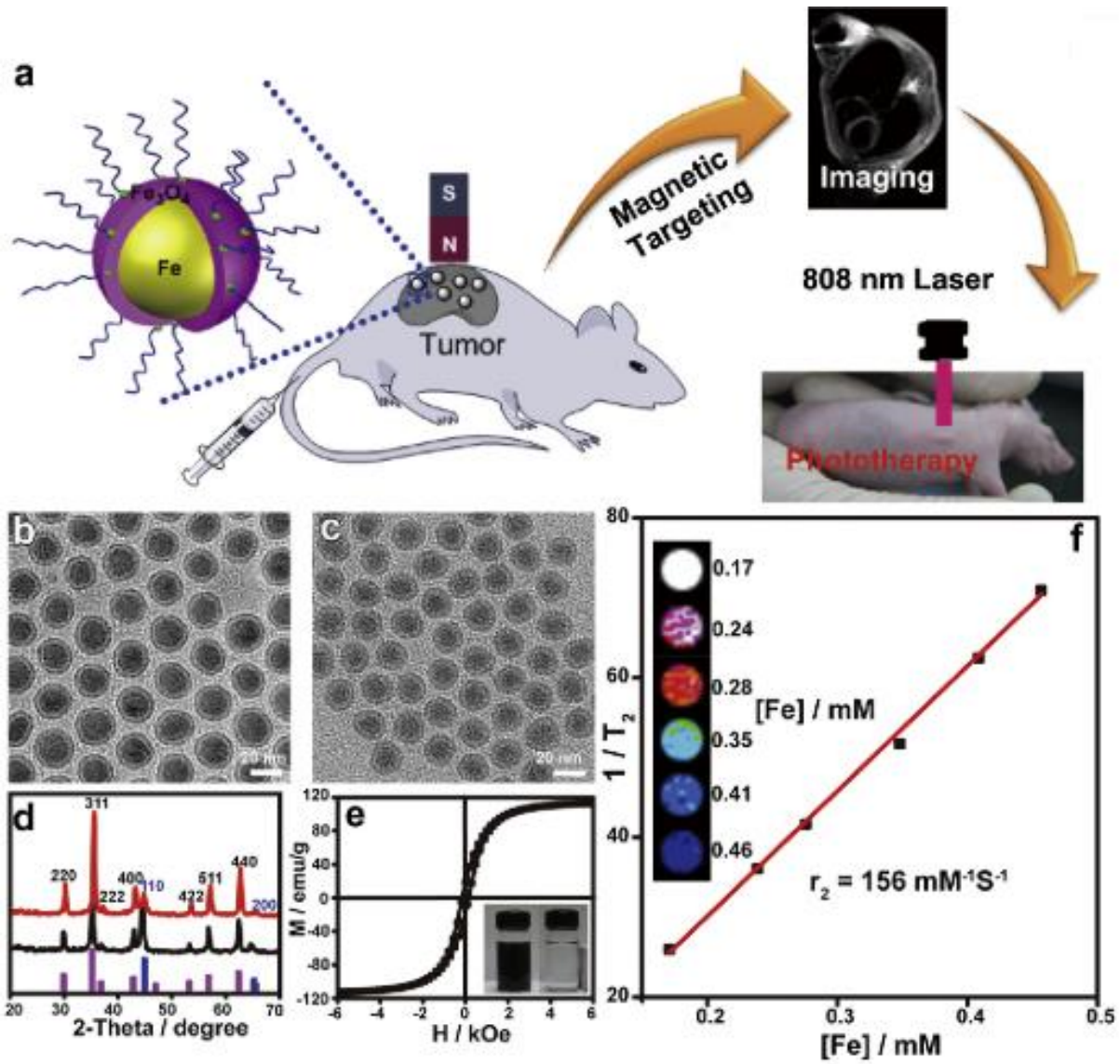
http://www.rpip.tohoku.ac.jp/seeds/profile/330/lang:en/

- Erken tanı ve tedavi için biomarkerlar.
- Hastalığın erken safhalarında belirlenmesini sağlayan araçlar.
- Nanopartikül kan plazmasındaki enfeksiyon içeren yerlere tutunarak görüntüleme sağlanabilir.
- Virüs ya da bakteriler saatler içinde belirlenebilir.
- Gümüş nanoçubuklar, karbon nano tüpler, altın nanoparçacıklar

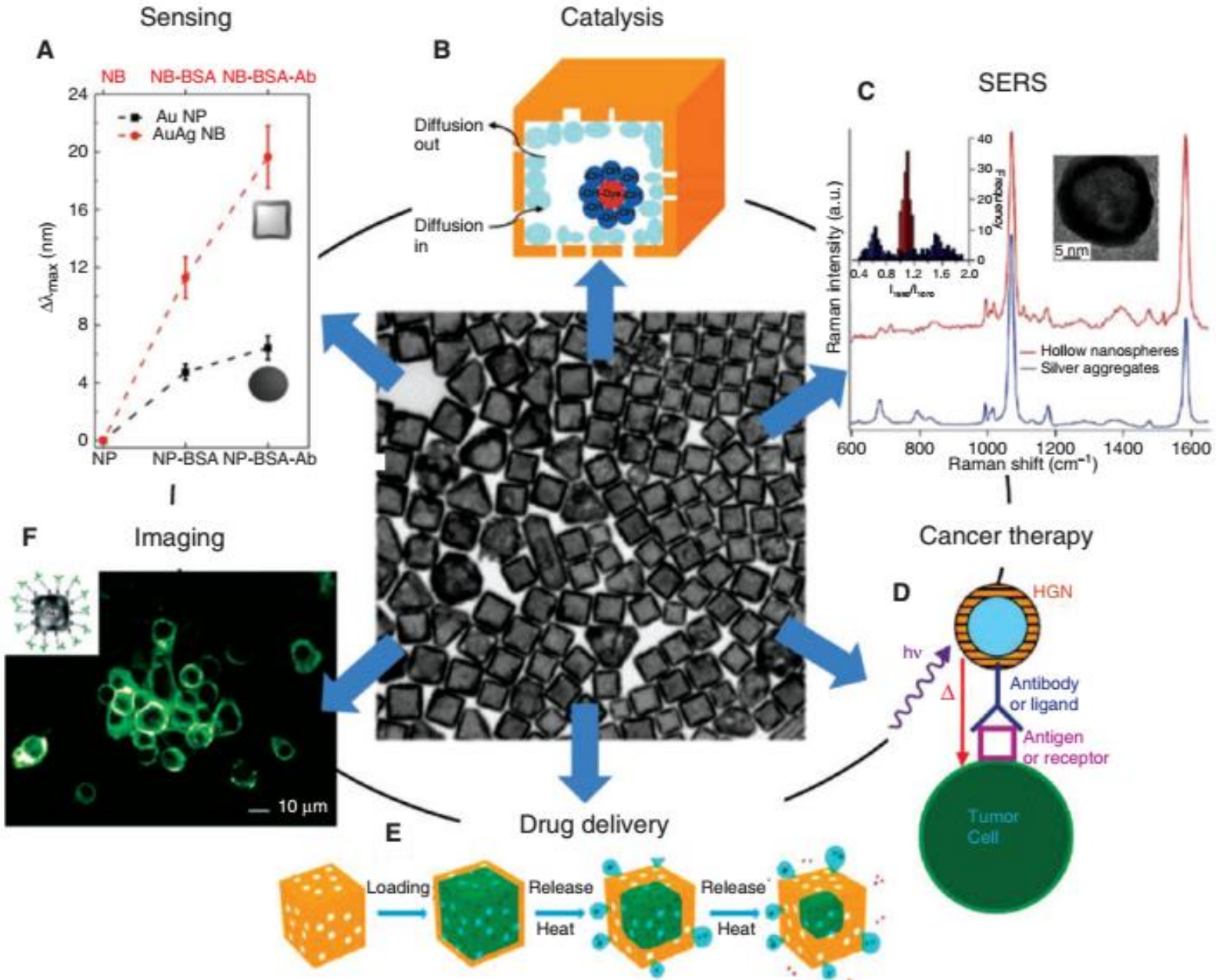
Tıp ve Sağlık

Tanı için görüntüleme

- Floresan, Manyetik Rezonans Görüntüleme (MRI), Ultrasonik, X-Ray bilgisayar tomografi…
- Görüntülenen dokunun düşük konsantrastyondan dolayı MRI sınırlanmakta ancak SPIONS (superparamagnetic iron oxide nanoparticles) manyetik görüntülemede kontrastı artırarak yüksek çözünürlüklü görüntü elde edilebilmekte.

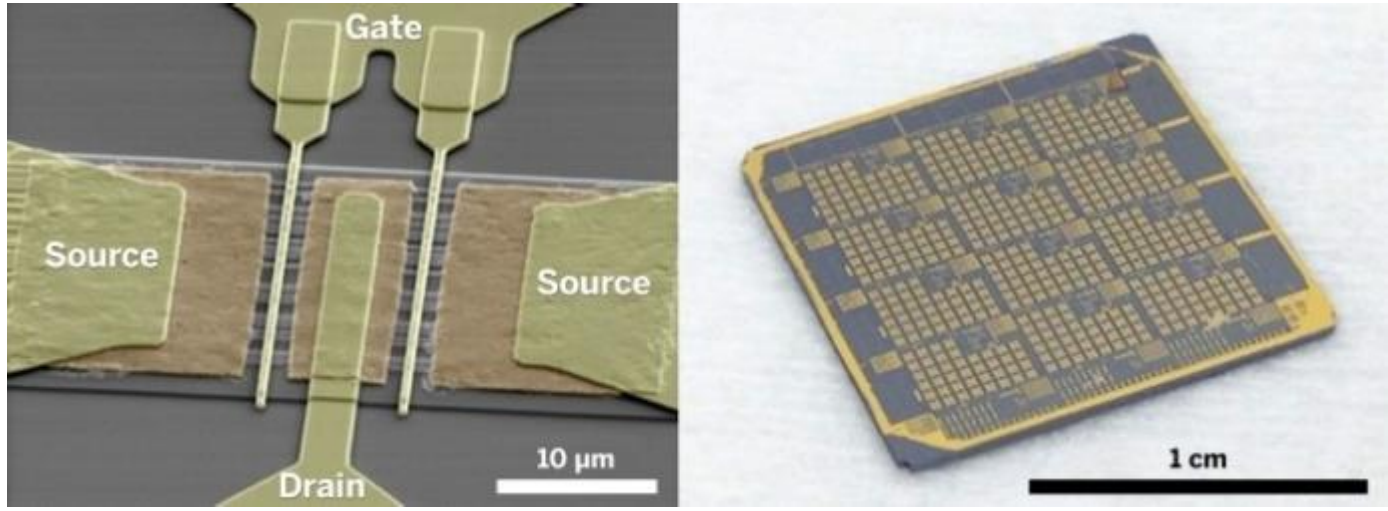


Tıp ve Sağlık



Bilişim ve Bilgisayar Teknolojileri

- Nano boyutta transistörlerin daha hızlı, daha güçlü ve enerji verimliliği yüksek hale gelmesi ile bilgisayar teknolojilerinin küçülmesi.
- Nano boyutta manyetik tünel kesişimlerinin hızlı ve verimli bir şekilde bilgi depolayabilmesi (manyetik rastgele ulaşım hafızası, magnetic random-access memory)
- Televizyon, bilgisayar, telefon vb ekranlara organik ışık yayan diyotların (OLED) entegresi ile daha kaliteli görüntüleme.



GaAs transistor (Nano Lett. 2014, DOI: 10.1021/nl503596j)

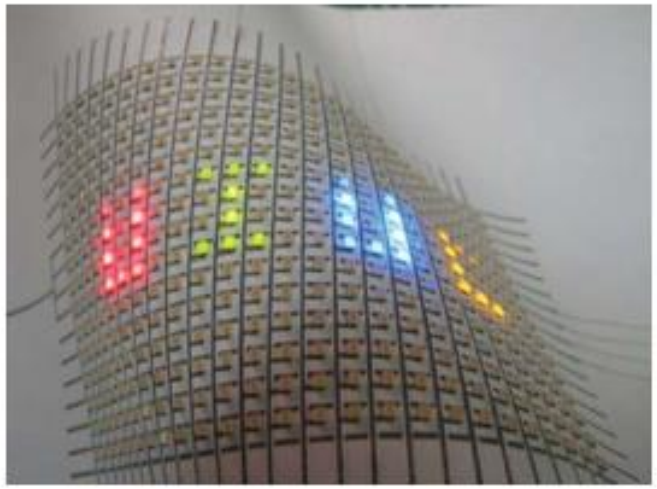


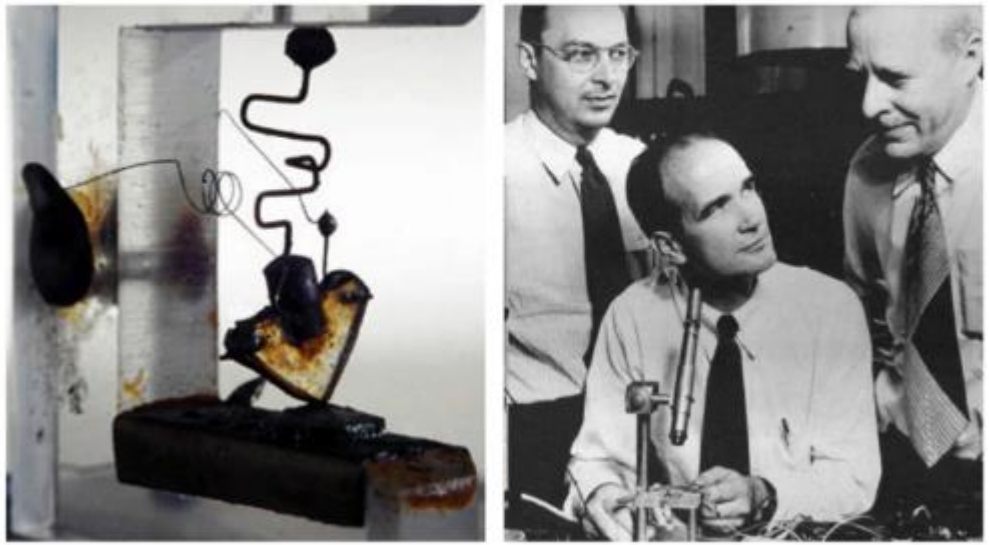
Figure 9.2 Optical image of a fl xible paper display containing an LED array (25 × 16). Russo et al. [9], ©2011. With permission of Wiley-VCH Verlag Gmbh and Co. (*See color plate section for the color representation of this figure.*)

Bilişim ve Bilgisayar Teknolojileri

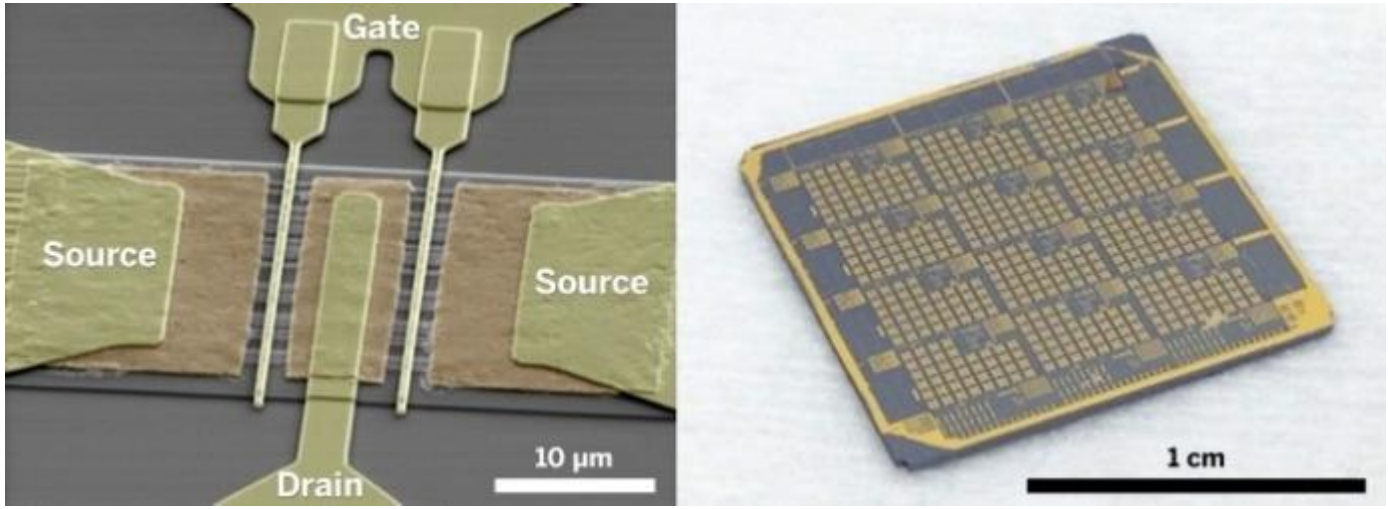
- Transistörler

Transistörün boyutu küçüldükçe, çip üzerindeki yoğunluğu artar, bu da herhangi bir cihazın işleme hızının artışına yol açar.

Point-contact Transistor –
Bardeen, Brattain, Schockley – 1948



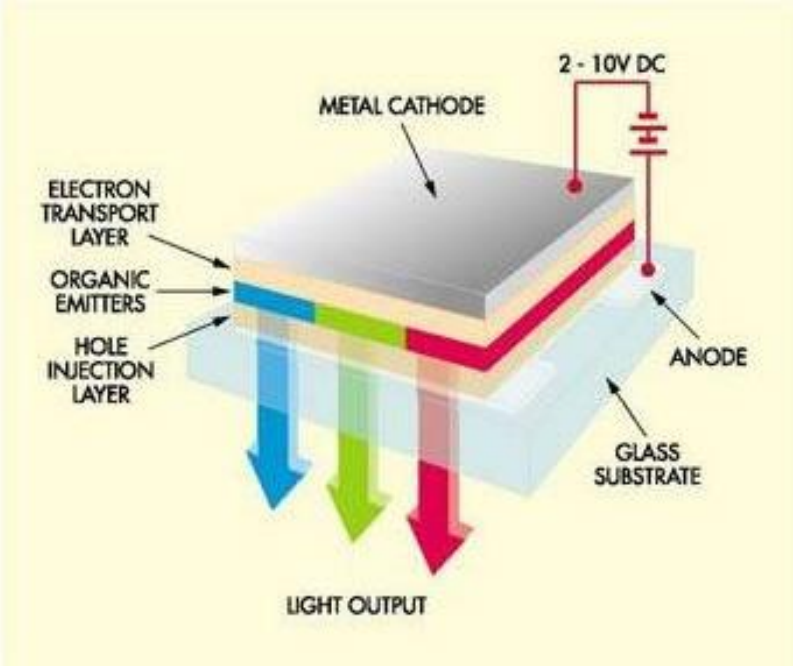
http://history-computer.com/ModernComputer/Basis/transistor.html



GaAs transistor (Nano Lett. 2014, DOI: 10.1021/nl503596j)

Bilişim ve Bilgisayar Teknolojileri

- OLED
- Akım ile uyarıldığında ışık yayan malzemeler, mobil telefon, MP3 player, TV, Dijital kamera gibi birçok uygulamada kullanılmaktadır.
- Farklı özelliklere sahip silikon, cam, plastik, kağıt gibi altlıklara entegre edilebilmekte
- OLED'ler düşük maliyetle, büyük alanlara, esnek plastik altlıklar ile eğilip bükülerek istenilen yere monte edilebilmektedir



Nanoelektromekanik sistemler (NEMS)

- Otomotiv endüstrisinde kullanılan basınç sensörleri, akıllı süspansiyonlar, navigasyon, araç güvenliği gibi uygulamalar
- Nano cımbızlar
- Kozmetik uygulamalar için cilt analiz sensörleri

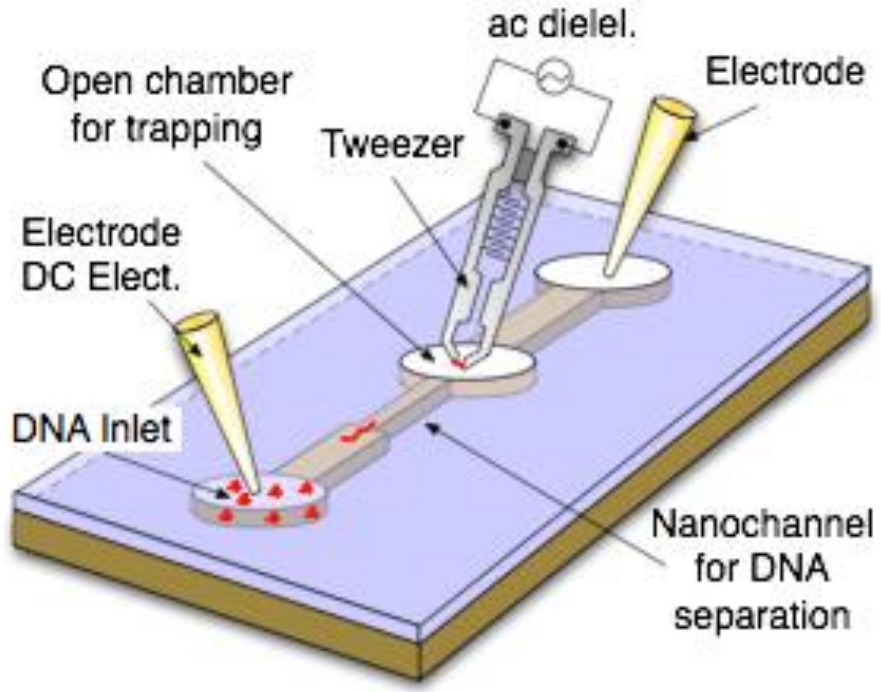
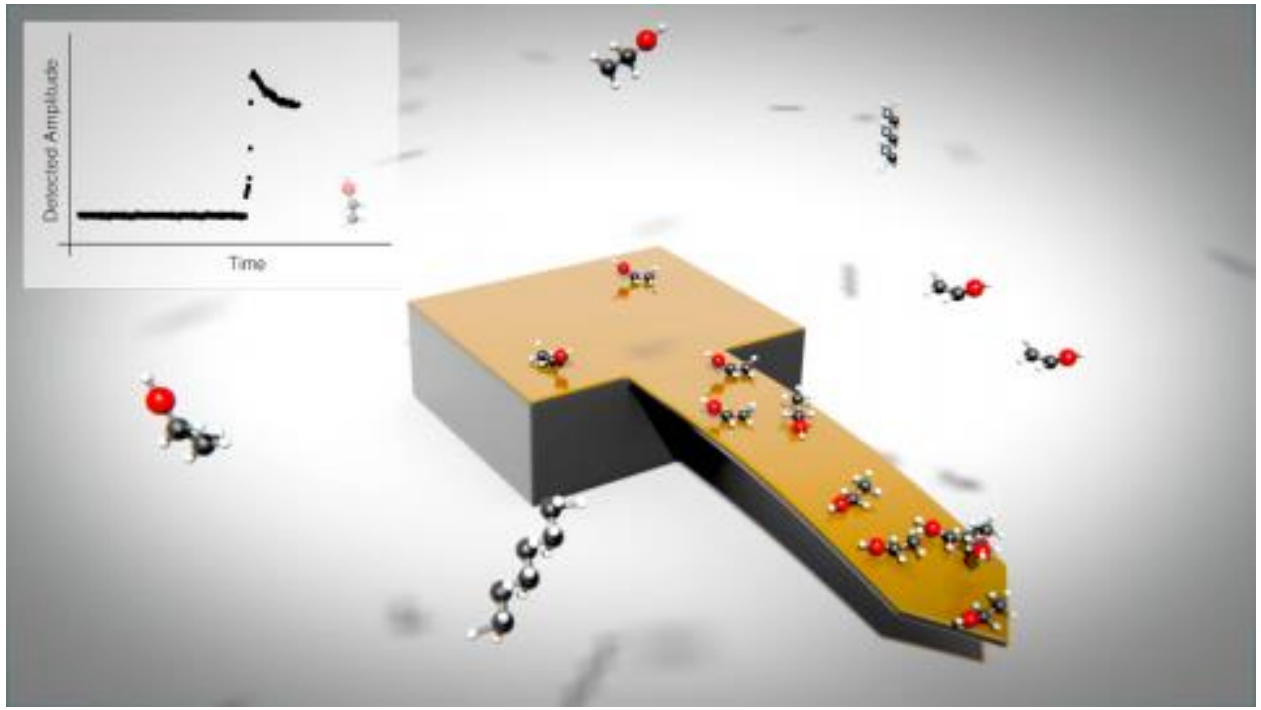


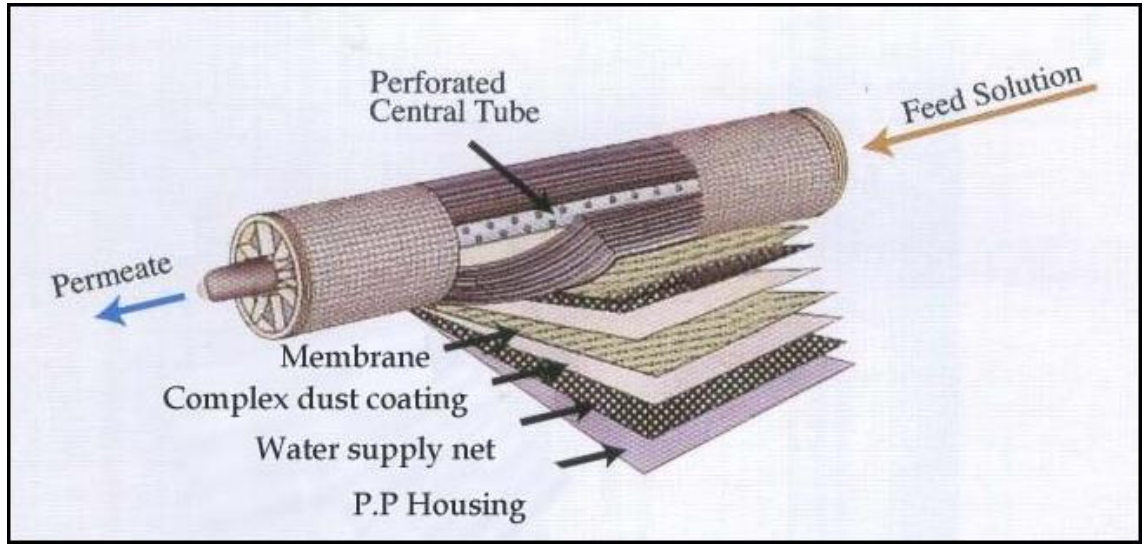
Fig.1 : Principle for DNA molecule isolation and trapping by nano-tweezers

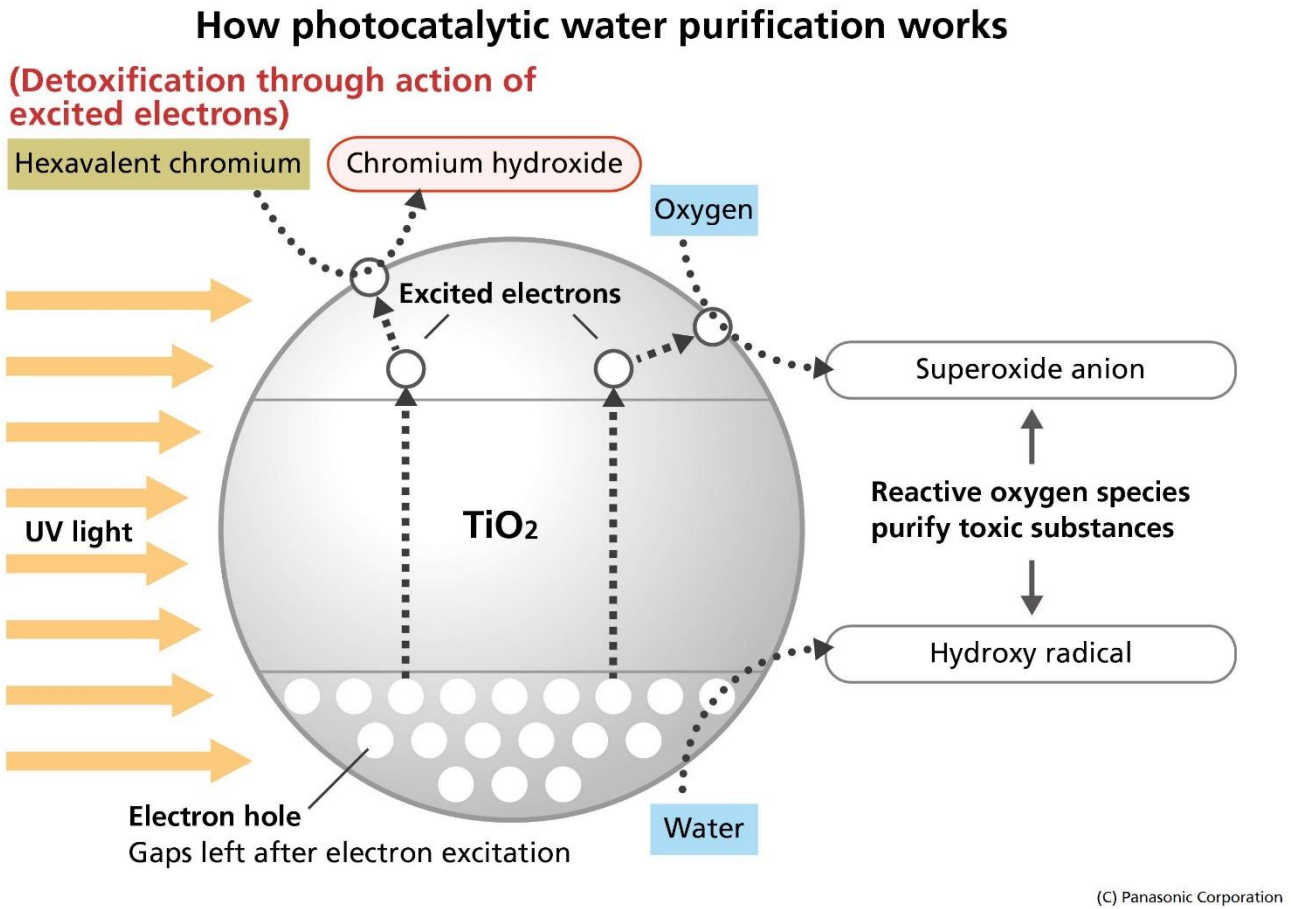


Warner J Venstra *et al* 2014 *Nanotechnology* **25** 425501

Çevresel Uygulamalar

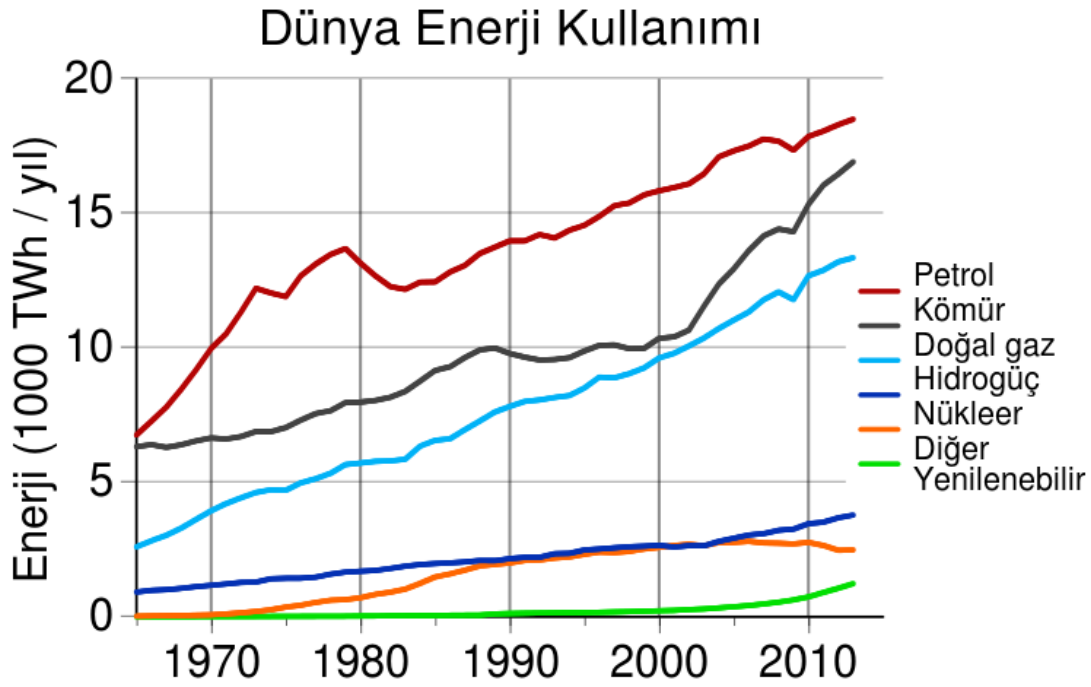
- Filtreleyerek veya içerisindeki zararlı bileşikleri parçalayarak su temizleme.
- Araba egzozları, fabrika bacaları gibi kirli hava çıkışı olan yerlere koyulan nanokatalizörlerle ya da karbon dioksit elimini sağlayan nanoyapılarla hava temizleme.

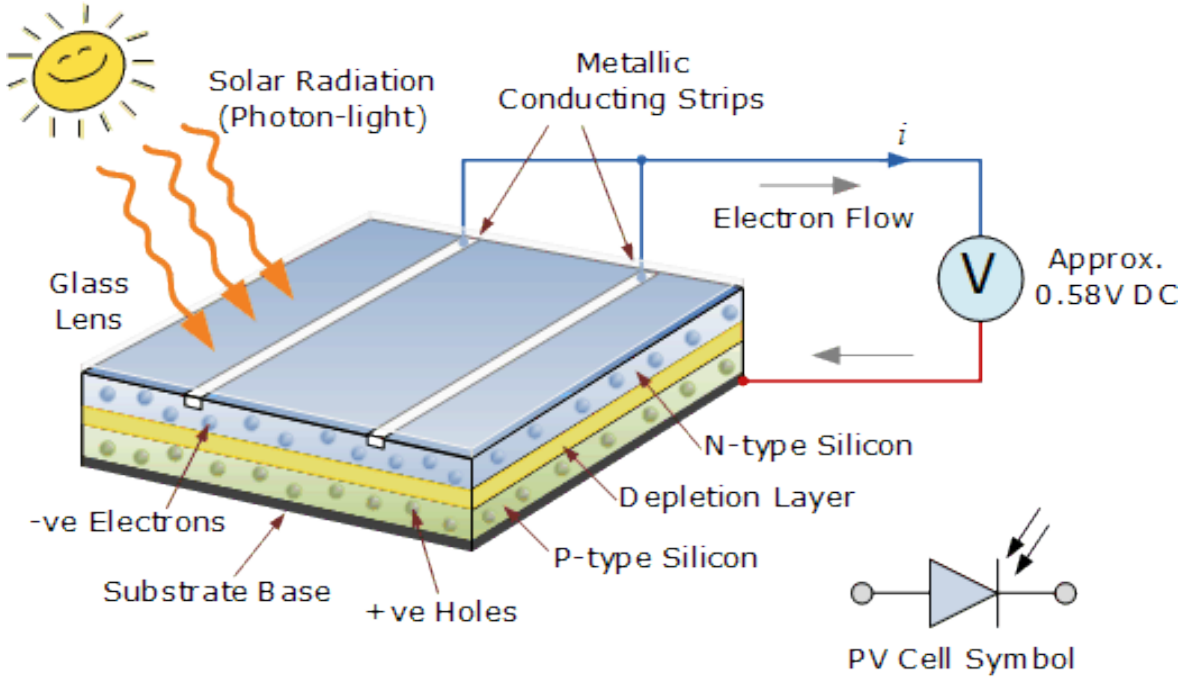




Enerji: Güneş Panelleri

- Günümüzde, dünya çapında toplam enerji tüketimi 15 TW. 2050 ‘de 2 katı olacağı öngörülmekte.
- Güneşten günlük gelen enerji 165.000 TW
- Her gün güneş ile enerji banyosu yapmaktayız, Richard E. Smalley.
- Güneş panelleri verimleri %15-20 ve pahalı
- Güneşten gelen enerji gün içinde ve yıl içinde stabil değil





Enerji: Termoelektrik

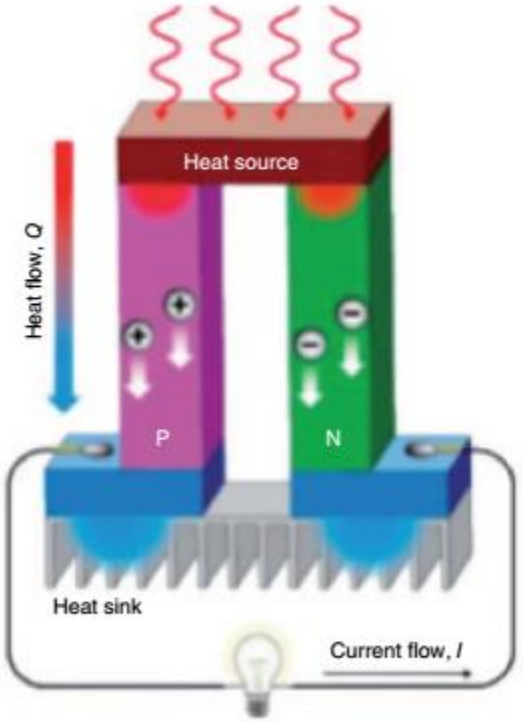


Figure 9.8 Thermoelectric devices. Li et al. [19], © 2010. With permission of NPG.

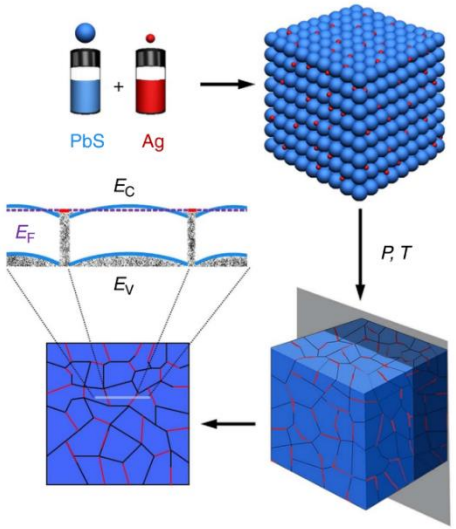
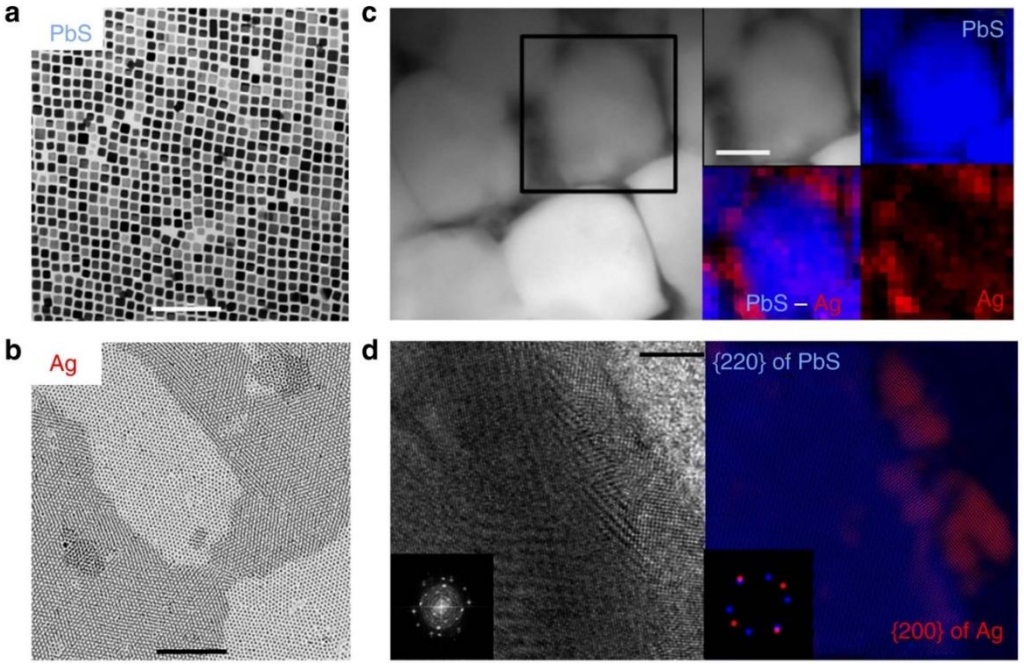
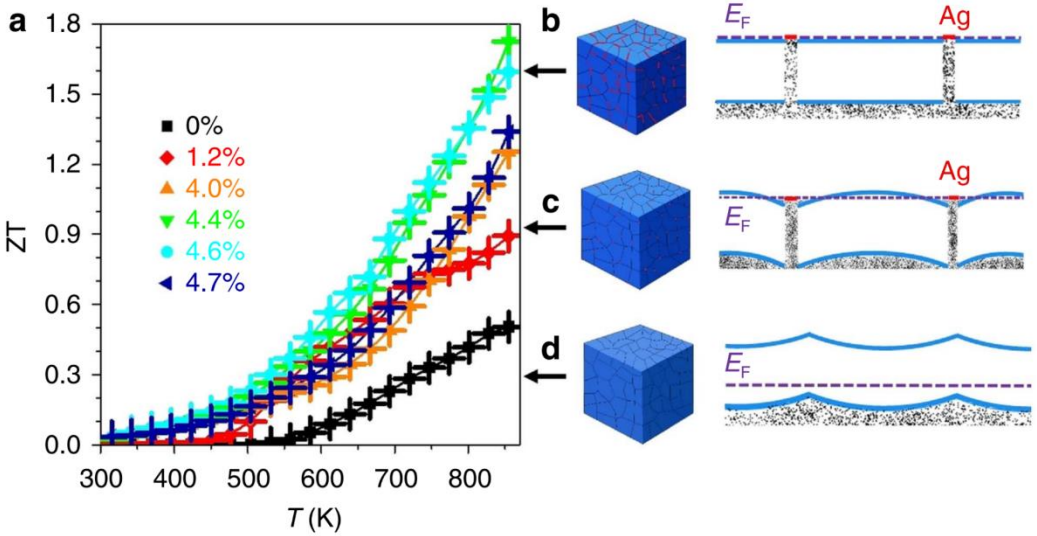


Figure 1 | Bottom-up Design. Bottom-up assembly process to produce PbS–Ag TE nanocomposites from the assembly of PbS (blue) and Ag (red) NCs, and the corresponding band alignment of the resulting nanocomposite.





$$ZT = \frac{S^2\sigma}{\kappa}T$$

Enerji: Piezoelektrik

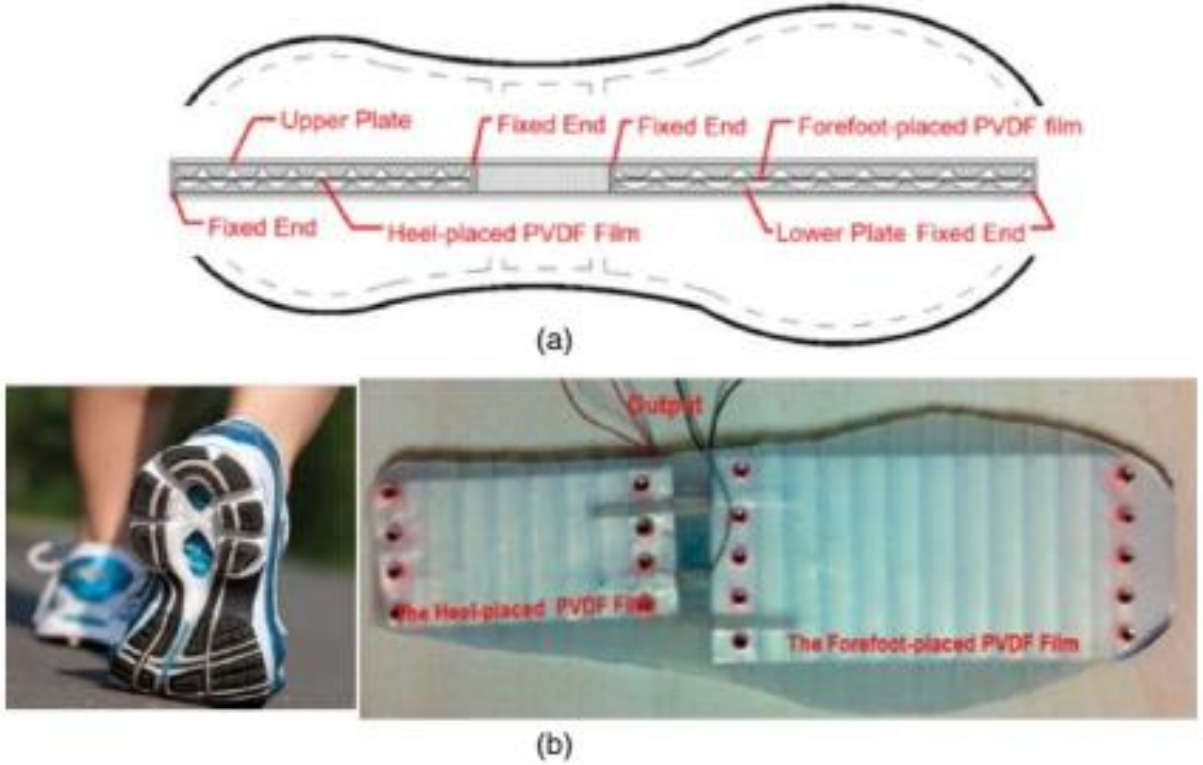
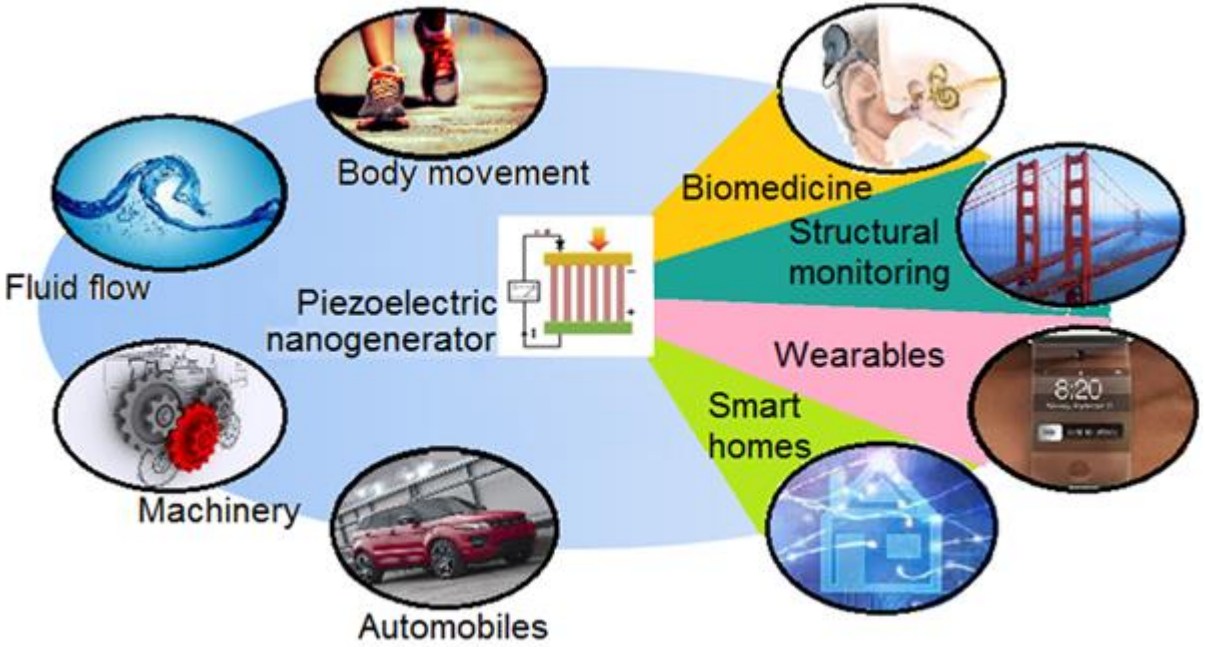


Figure 9.9 (a, b) Nanowires made of piezoelectric materials embedded in shoe sole to generate electricity from mechanical motion such as a human walking or running. http://www.mdpi.com/1424-8220/14/7/12497. Used under CC-BY 3.0. http://creativecommons.org/licenses/by/3.0/. (*See color plate section for the color representation of this figure.*)



Enerji: Piller

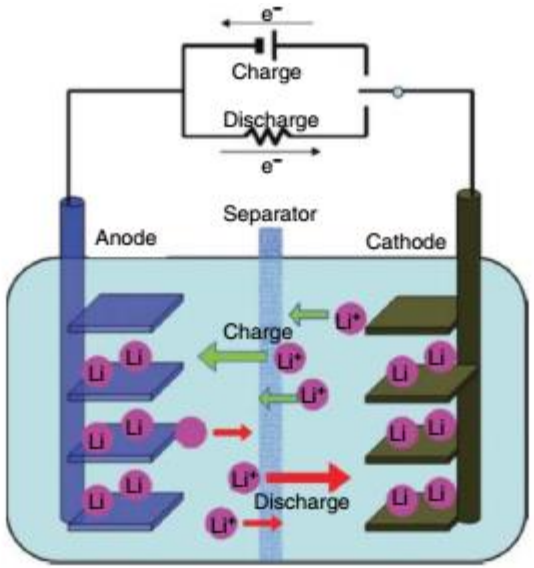


Figure 9.12 Schematic representation of a lithium-ion battery. Dai et al. [22], © 2012. With permission of Wiley VCH Verlag.

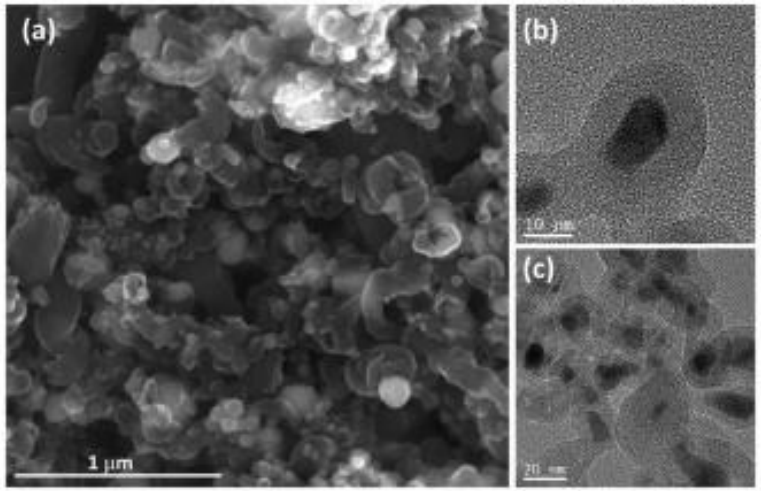
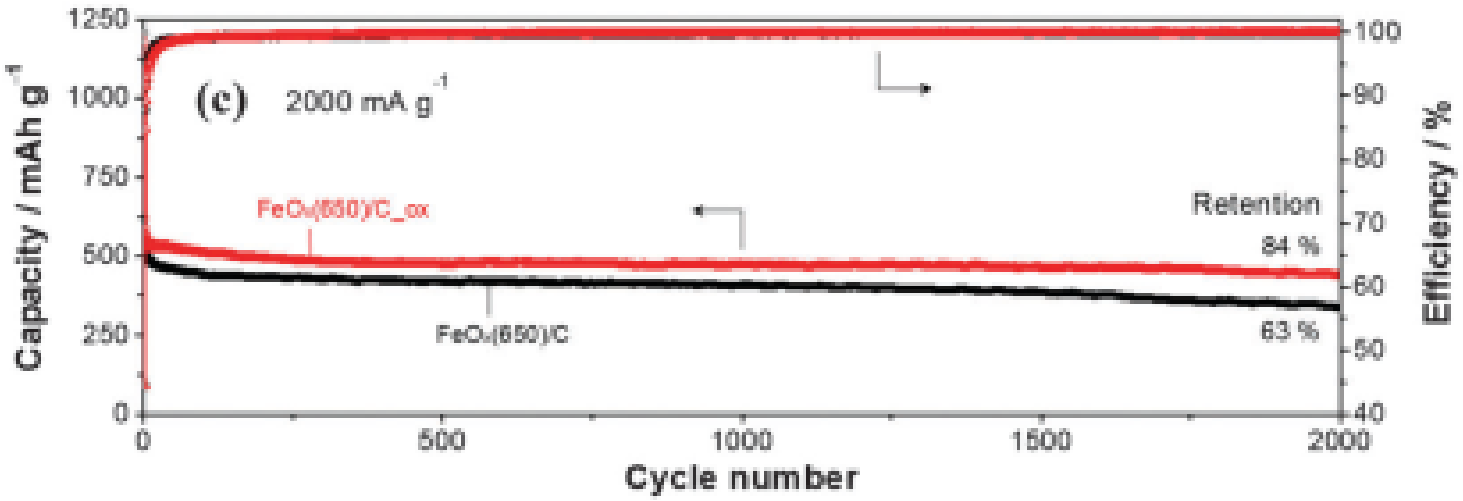
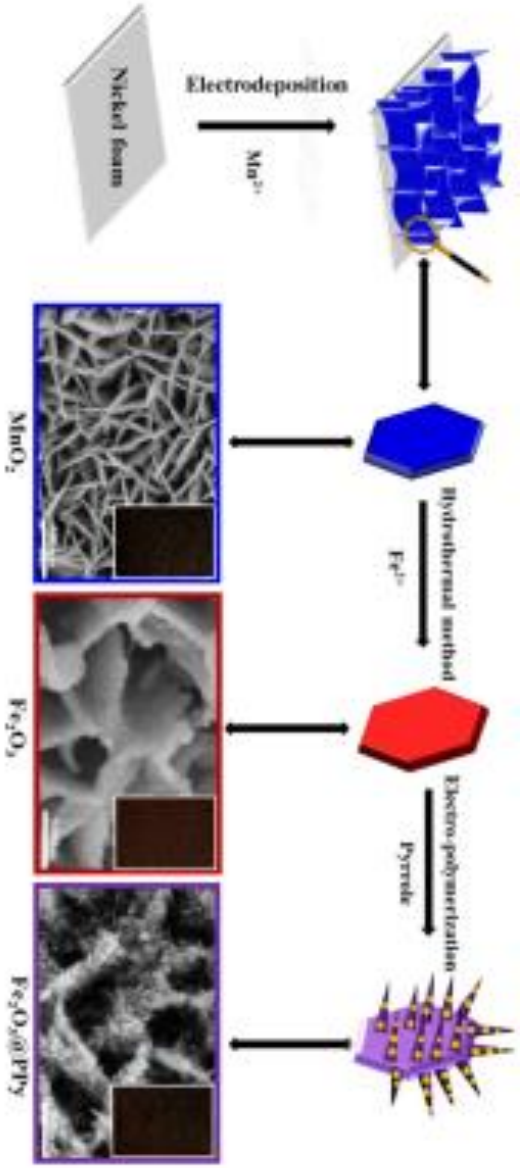


Fig. 1 (a) SEM micrograph, (b) and (c) TEM micrographs of FeO_x(650)/C.



Enerji: Süperkapasitörler



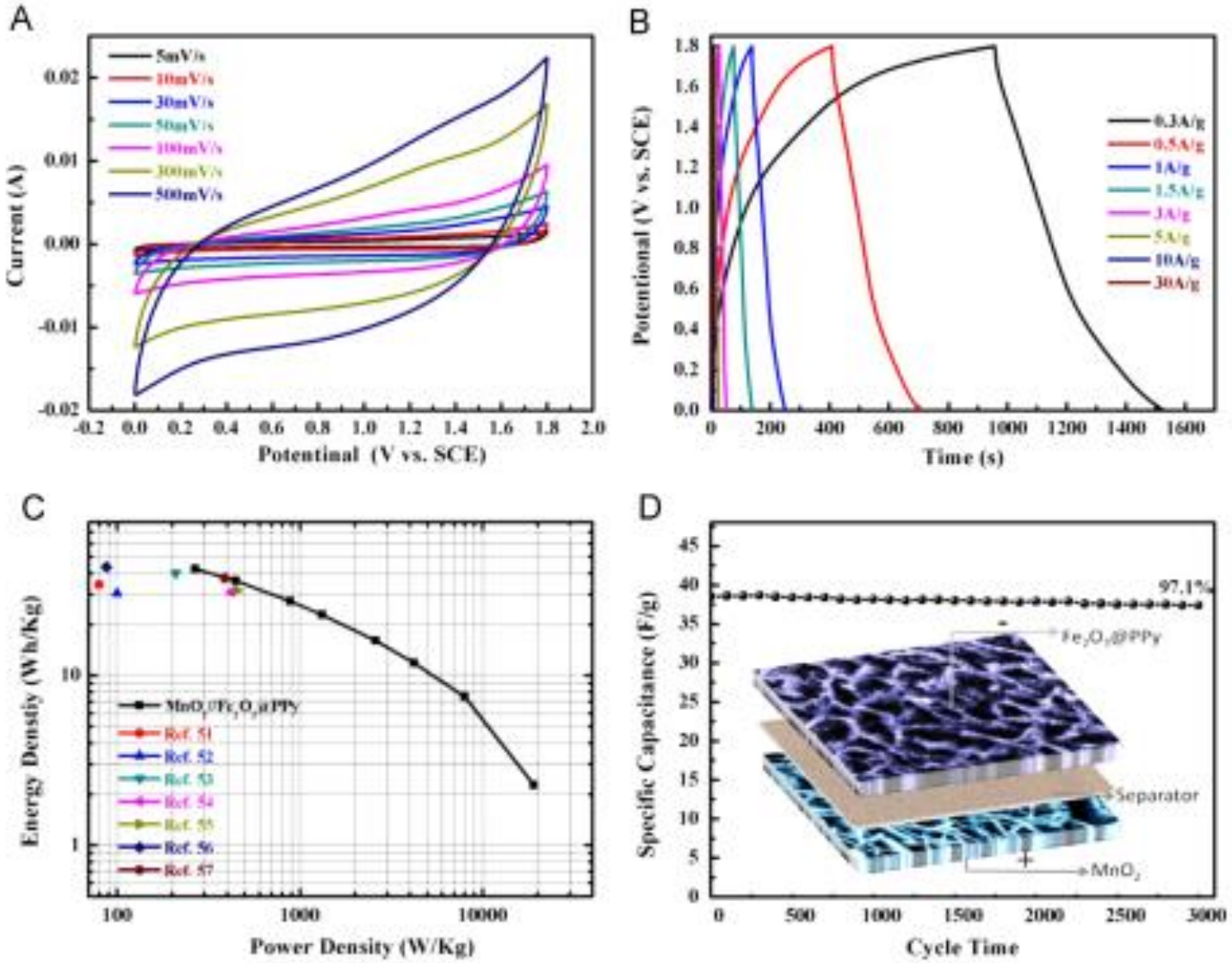
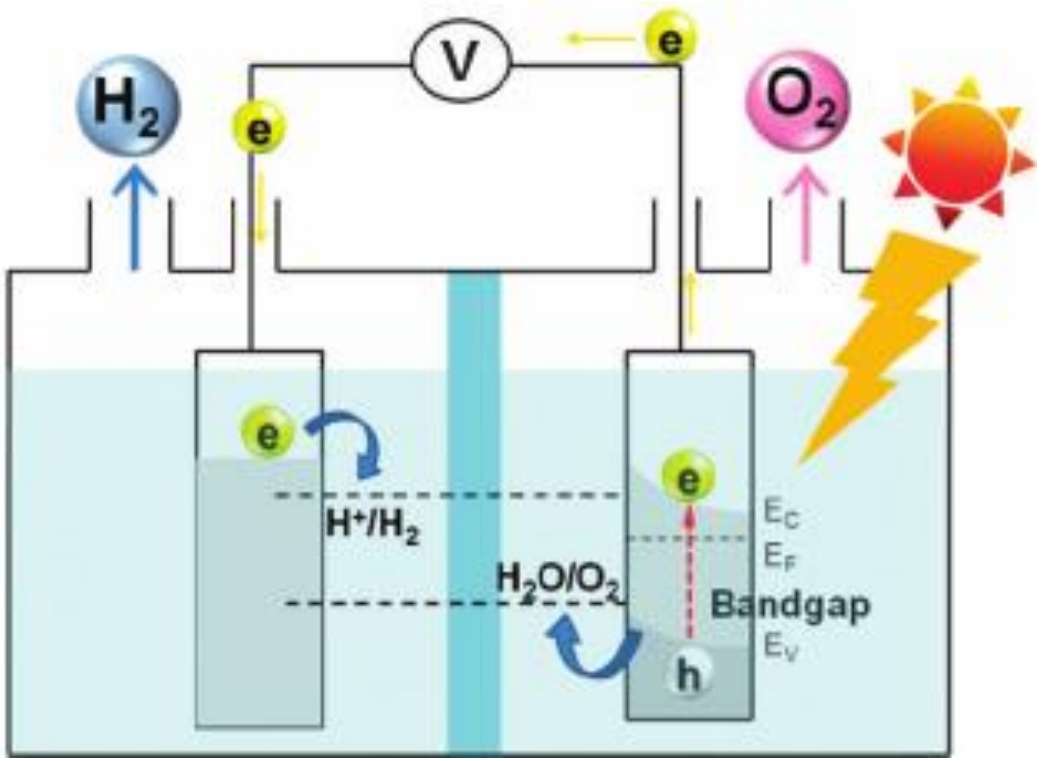
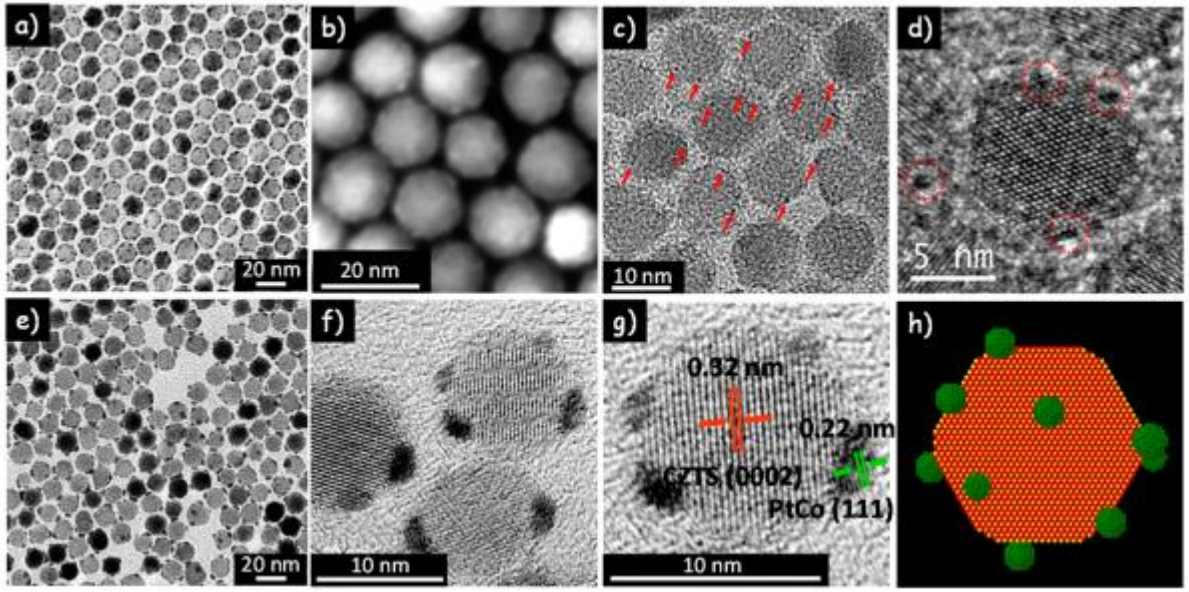


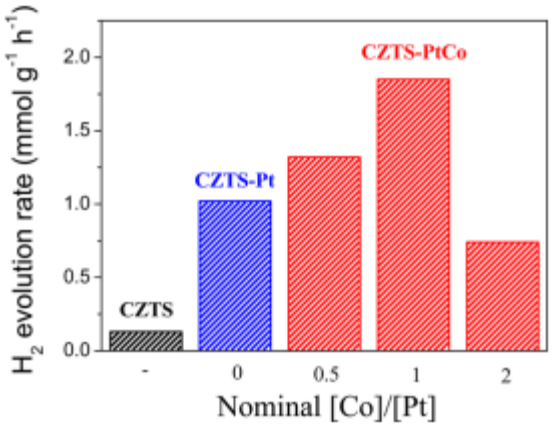
Figure 5 Electrochemical properties of bi-metal oxides ASC: (A) CV curves at different scan rates, (B) the GCD curves at different current densities, (C) the Ragone plot, (D) the life cycle stability at a current density of 3 A g^{-1} (the schematic of the ASC device shown in the inset).

Enerji: Fotoelektrokimyasal Hidrojen Üretimi

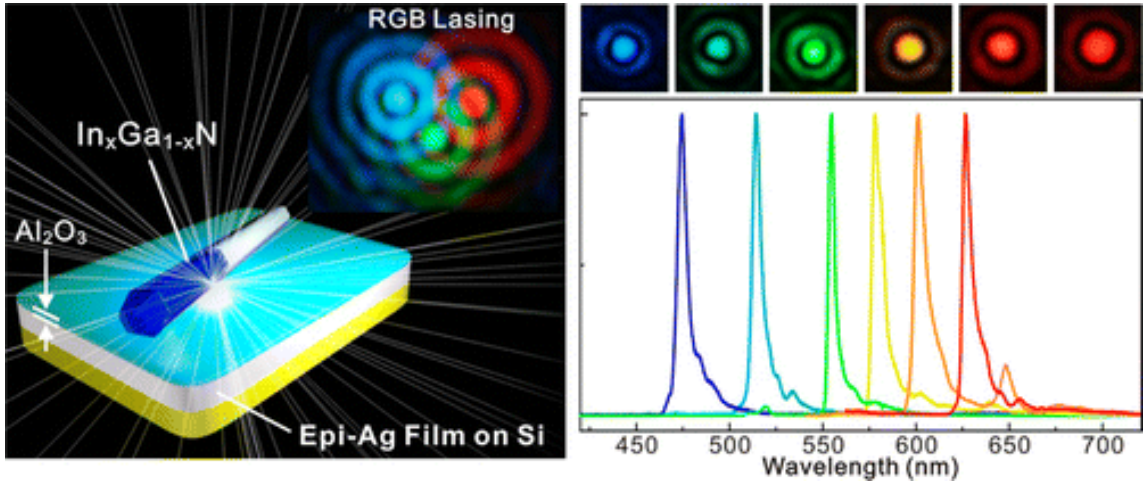


Chemical Society Reviews 41(17):5654-71





Optik Uygulamalar



Nano Lett., 14 (8), pp 4381–4388 (2014)

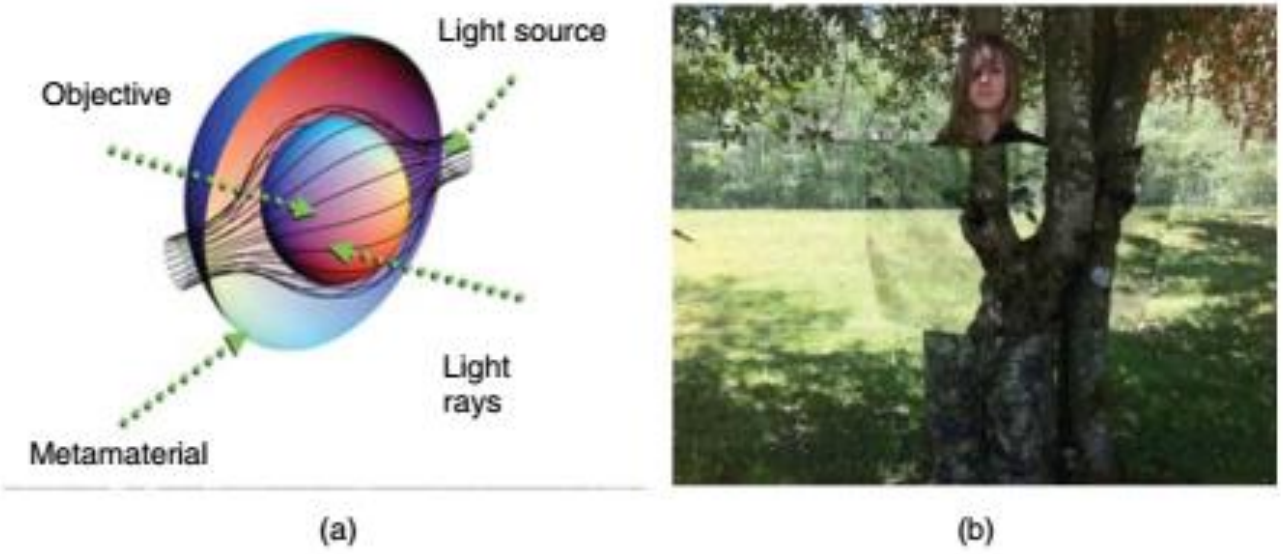


Figure 9.13 The complete invisibility system based on metamaterials: (a) Schematic representation of metamaterial showing bending of light. http://www.physics.org. (b) Quantum stealth mock-up using metamaterial. Courtesy of G. Cramer, Hyper Stealth Biotechnology Corp. [27]. (*See color plate section for the color representation of this figure.*)

Kozmetik Uygulamalar

- Nemlendiriciler, Saç bakım ürünleri, Makyaj malzemeleri, Güneş koruyucuları
- Gümüş nanopartiküller antibakteriyel özellik için; TiO2 ZnO güneş kremleri; nanoyapılı lipit taşıycılar ve fullorenler nemlendirici, anti-ageing vb.

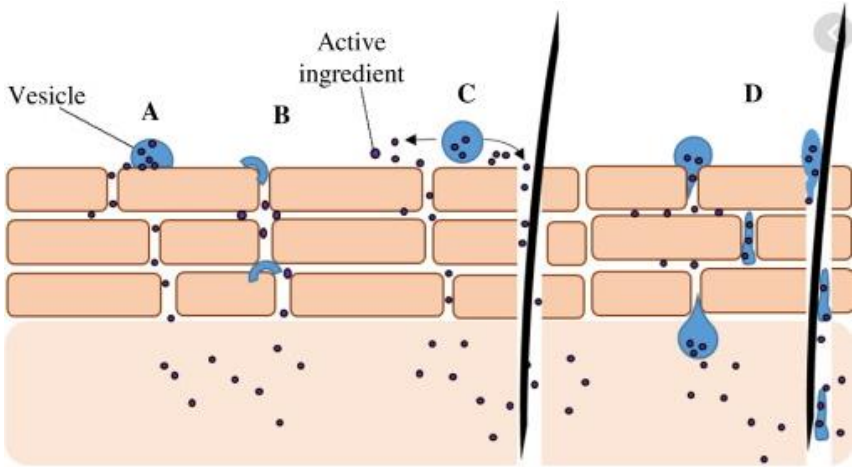



Figure 9.15 Antibacterial textiles: (a) interaction between bacteria and coating of AgNPs within sol–gel-based silicate material. Hamm et al. [35], © 2012. With permission of ACS; (b) doctor's sterile suit containing nanosilver. http://www.ecouterre.com/. (*See color plate section for the color representation of this figure.*)