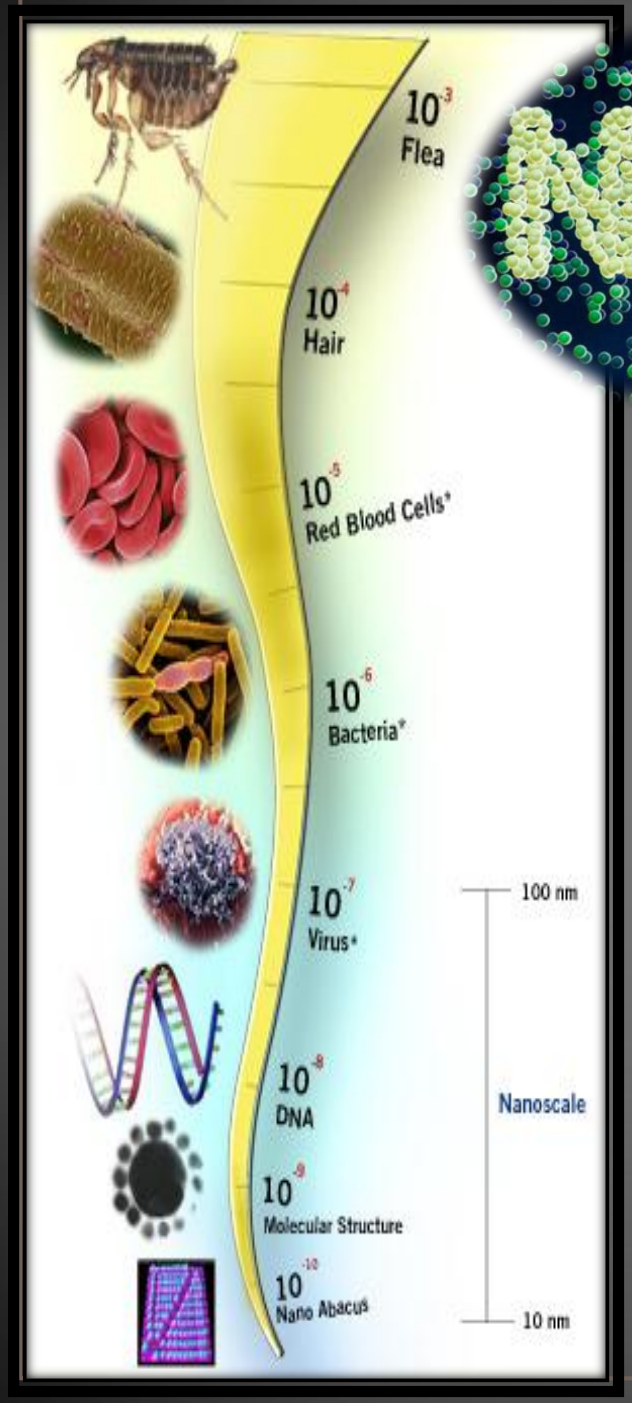
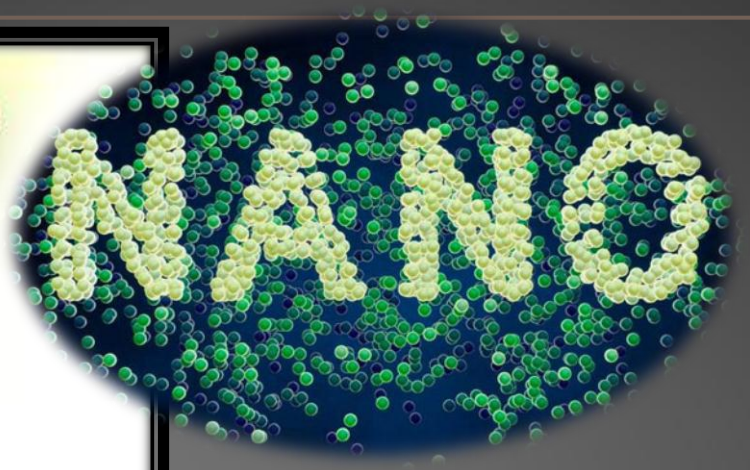
Nanoteknoloji ve Kimyadaki Bazı Uygulamaları

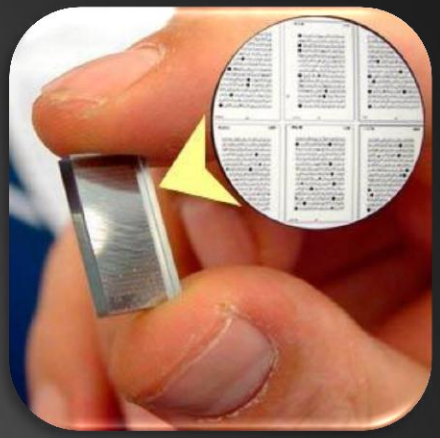
Prof. Dr. Mustafa Soylak

Erciyes Ün. Fen Fakültesi Kimya Bölümü, Kayseri
E-posta: soylak@erciyes.edu.tr
Kişisel web sayfası: www.soylak.tr.gg

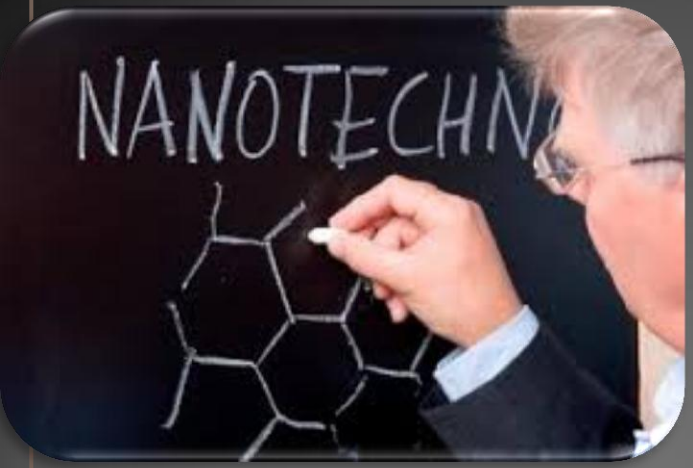
YAKIN DOĞU ÜNİVERSİTESİ 31.5.2018







- Nano Yunanca cüce kelimesinden alınmış olup 10^{-9} dur. Metre mm– um– nm yani metrenin milyarda biri uzunluğu ifade eder. Bir saç telini 50 binde biri kadar küçük, ancak 10-20 atom büyüklüğünde bir büyüklüktür.



Nanoteknoloji Nedir?

- Nanometre ölçeğinde fiziksel, kimyasal ve biyolojik olayların anlaşılması, kontrolü ile bu boyutlarda fonksiyonel malzemelerin, araçların ve sistemlerin geliştirilmesi ve üretimidir.
- Milyarda bir ölçekte çalışarak (0,1 – 100 nm) ürünlerde/tekniklerde yenilik oluşturmak ve/veya yeni ürünler/teknikler geliştirmektir.
- Nanoteknoloji ile nano ölçekteki olayların değerlendirilip, benzerlerinin geliştirilerek uygulanmasıyla bilimde yeni ufuklar açılmaktadır.

İlgi ve Amaç

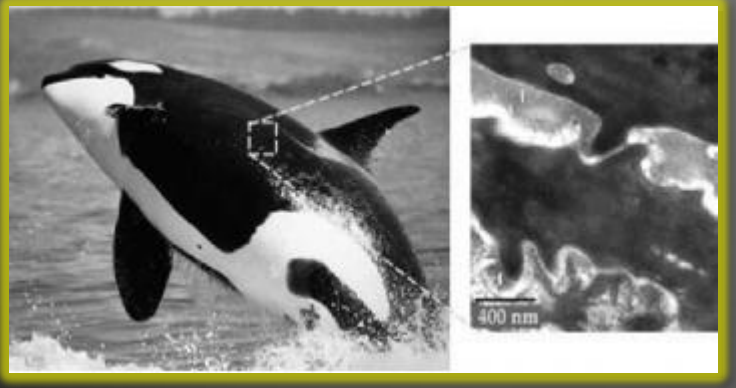
En az bir boyutu 1-100 nm olan materyaller, cihazlar ve sistemler ile ilgilenir. Daha farklı ve üstün nitelikli mekanik, elektrik, ısıl, optik ve kimyasal özelliklere sahip materyal ve sistemler geliştirmeyi amaçlar.

- ✓ Nano ölçekteki yapıların analizi,
- ✓ Nano boyuttaki yapıların fiziksel özelliklerinin araştırılması ve anlaşılması,
- ✓ Nano ölçekli malzemenin üretimi,
- ✓ Nano duyarlıkta aletlerin geliştirilmesi,
- ✓ Nanoskopik ve Makroskopik dünya arasında bağ kurulmasına yardımcı olacak yöntemlerin bulunup geliştirilmesi

Doğadan Nano izlenimler

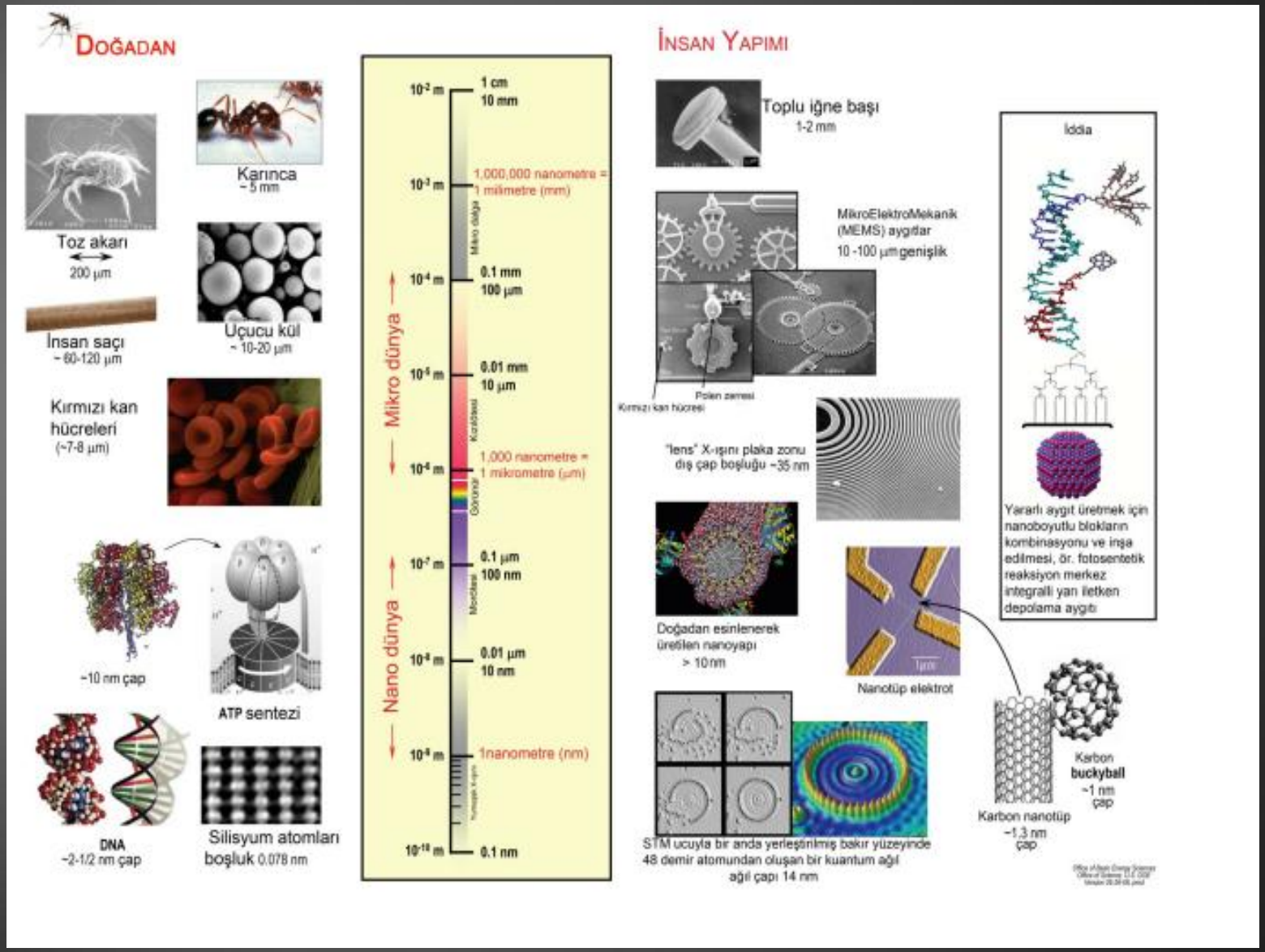
Namib çölü böceğinin mükemmel su toplama tekniği ve nilüfer çiçeği yaprağındaki nano boyuttaki su damlacığı

Katil balina: nano yüzey



Lotus yaprağının yüzeyinde bulunan mikron ve nano seviyesindeki çukur ve tepecikli yapılar sayesinde, bitkinin yaprakları kesinlikle ıslanmaz ve kirlenmez.

NANO YAPILAR



Boyut ve Malzeme Özellikleri

- Nanometre seviyelerinde malzemelerin temel özellikleri (ergime noktası, manyetik özellikler, mekanik özellikler, kimyasal özellikler, renk) kimyasal bileşimi değiştirmeden kontrol edilebilir.
- Nanometre seviyesinde maddenin özellikleri mikro seviyeden farklıdır.

1980’ler den Bir Fıkra:

Amerikalılar ile Japonlar iddiaya girmişler "en ince teli biz yaparız diye. İlk önce amerikalılar çok küçük bir tel yapmışlar ve japonlara göndermişler. Japonlar bu teli almış ve yarısı kadar başka bir tel yapıp tekrar amerikalılara göndermişler. Amerikalılar bu telin onda biri kalınlığında başka bir taneyi japonlara tekrar göndermişler. japonlar bu sefer gelen telin 50'de biri kalınlığında bir teli geri göndermişler. Amerikalılarda bu telin yüzde biri kalınlığında başka bir teli tekrar japonlara göndermişler ama artık bundan küçüğünü de yapamazlar deyip sevinmeye başlamışlar. Japonlar almış aynı teli tekrar geri göndermişler Amerikalılar "haha en incesini biz yaptık" deyip japonları aramışlar "eee bizim teli geri göndermişsiniz demişler. Japonlarda sakin bir tavırla telin ortasına bakın demişler. Adamlar telin ortasından bir delik açıp geri göndermişler

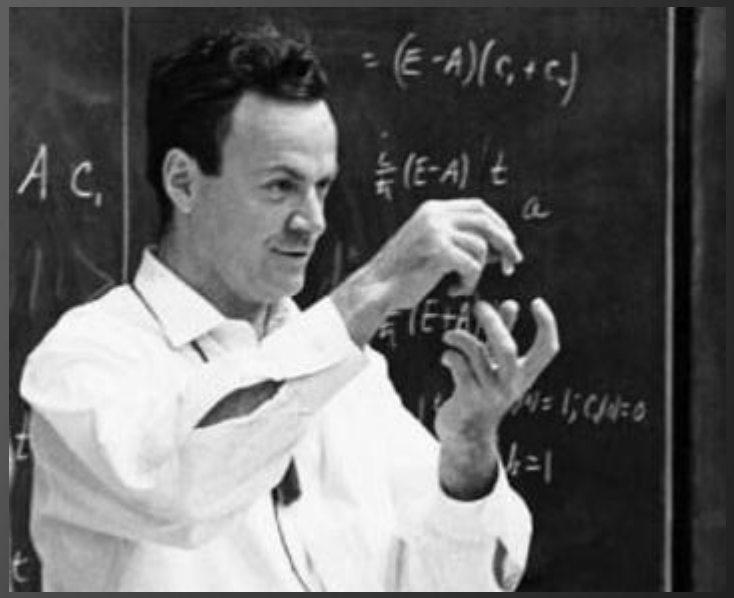
Saç telinin 60 binde biri kalınlığında motor

6 Eylül 2011 tarihli Hürriyet Gazetesi

- Milimetrenin milyonda biri büyüklüğünde motor geliştirildi. İnsan saç telinin 60 binde biri kalınlığındaki mini motorun tek kusuru, ancak çok soğukta çalışabilmesi.
  Nature Nanotechnology dergisinde yayımlanan makaleye göre, Amerikalı kimyagerlerin geliştirdiği elektrik motoru sadece tek bir molekülden oluşuyor. Bir nanometre çapındaki motor, elektrik enerjisiyle çalışıyor.
- (Massachussetts Tufts üniversitesi)
- Nature Nanotechnology
- Işık ya da kimyasal reaksiyonla çalışan moleküler motorlar konusunda bugüne dek önemli ilerlemeler sağlandığını, ancak kendilerinin, elektrik enerjisiyle sadece tek bir molekülün bile yönlendirilebileceğini gösterdiklerini belirtti.

Nanoteknolojinin Tarihi ve Gelişimi

- 60‘ lar-Feynman (Ünlü fizikçi Feynman 1959’da bir konferansda “aşağıda daha çok yer var” başlıklı konuşma yapmıştır. Feynman bu konuşmasında eğer atom ve molekül büyüklüklerinde imalat yapılabilirse birçok yeni keşiflerin olabileceğini söylemiştir.))
- Nanoteknolojinin Babası
- 1965 Nobel Fizik Ödülü sahibi



- 80‘ ler- mikroskopların geliştirilmesi:

-Taramalı Tünelleme Mikroskobu (TTM)

-Atomik Kuvvet Mikroskobu (AKM)

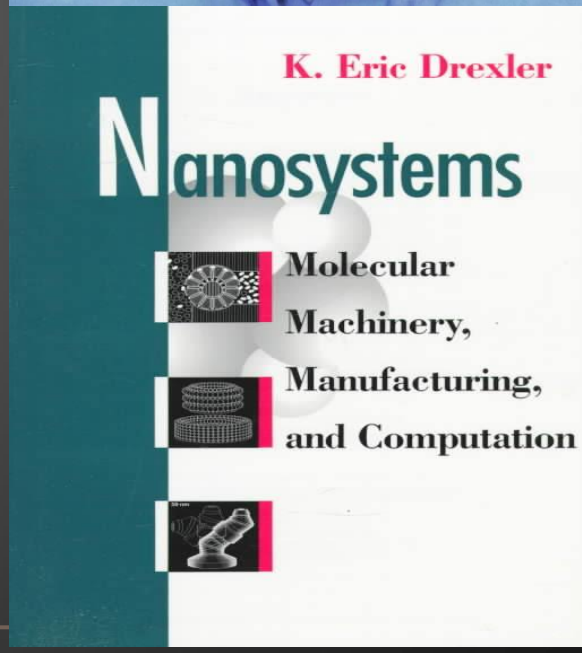
- 90’ lar Fullerene-Karbon Nanotüpler
- 1990 IBM Atomların pozisyonlarını kontrol etme: Eigler. STM ile 35 Xenon atomunu Nikel yüzeye yerleştirdi.
- 2000’ler Yarış devam ediyor

-Ulusal Nanoteknoloji Adımı (National Nanotechnology Initiative

- **K.Eric Drexler** (1955)

- Nanoteknoloji kavramını ilk defa dile getiren bilim adamıdır.

- Nanoteknoloji alanında yoğunlaşan foresight enstitüsü nün kurucusudur. MIT laboratuarındaki eğitimi sırasında, biyolojik sistemlerden esinlenerek, moleküler makineler yapılabileceğini önermiş, nano teknoloji kavramını ortaya atan kişi olmuştur.
- *Nanosystems: Molecular Machinery Manufacturing and Computation* (1992)



NANOTEKNOLOJİNİN KULLANIM ve UYGULAMA ALANLARI

- Tıp ve Sağlık Sektörü
- Malzeme ve İmalat Sektörü
- Nano Elektronik ve Bilgisayar Teknolojileri
- Havacılık ve Uzay Araştırmaları
- Çevre ve Enerji
- Biyoteknoloji ve Tarım
- Savunma Sektörü

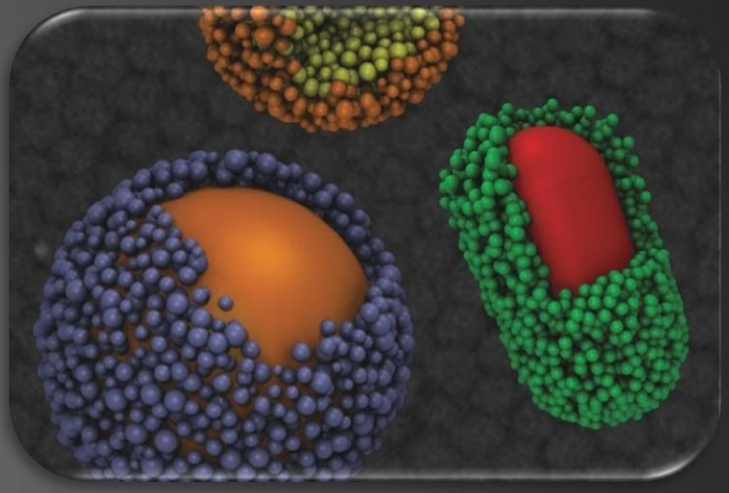
1 – Organik ışık yayıcı diyotlar
2 – Fotovoltaik filmler
3 – Kendi kendini temizleyen camlar
4 – Leke tutmayan kumaşlar
5 – Akıllı kıyafetler
6 – Akıllı çerçeve
7 – Biyouyumlu kalça eklemi
8 – Nano boyalar
9 – Termokromik cam
10 - Manyetik data saklayıcı
11 – Karbon nanotüp bataryalar
12 – Nano implant

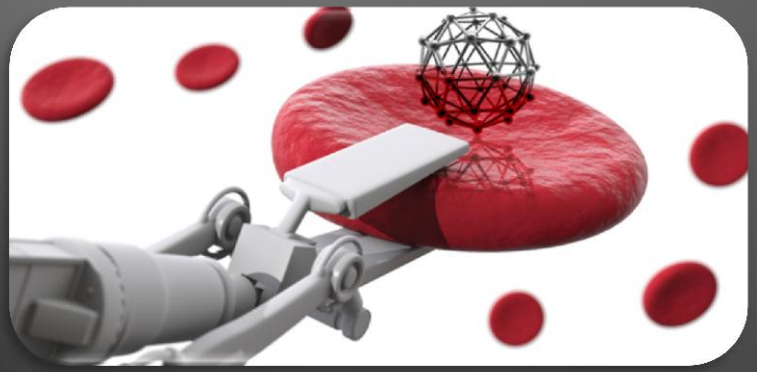
TIP ve SAĞLIK

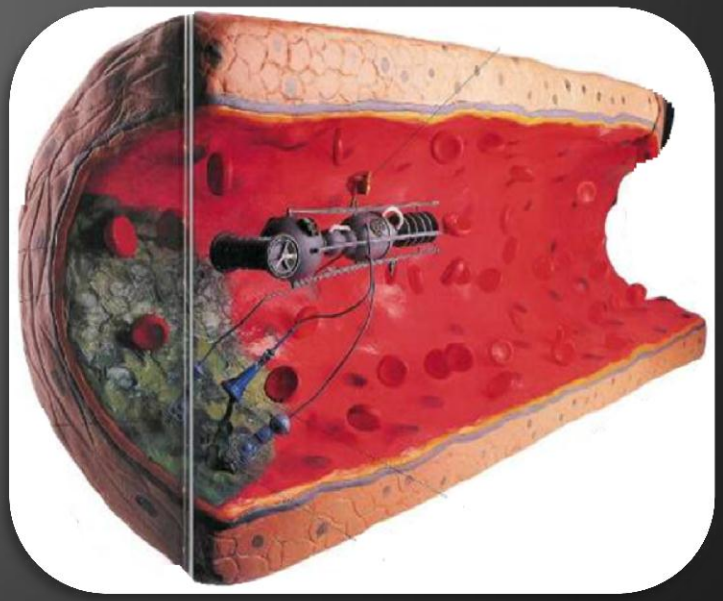
Nanobiyoteknoloji/Nanotıp

Moleküler seviyede:

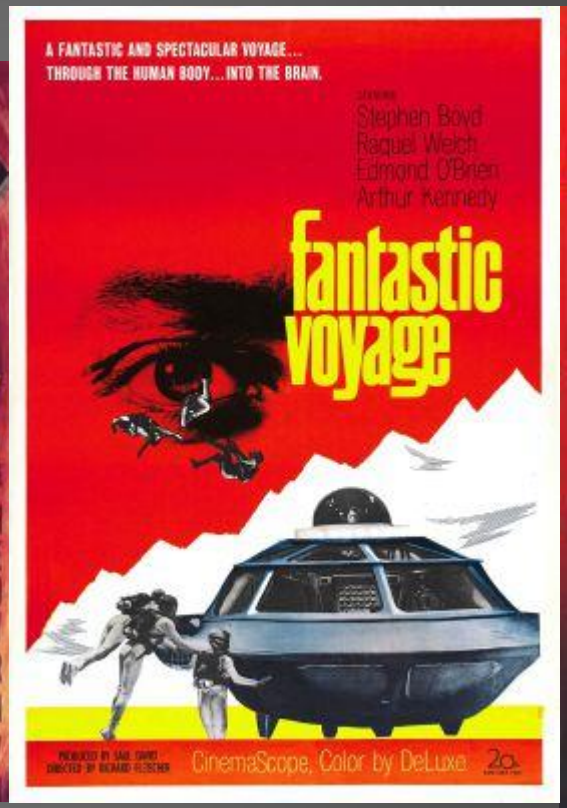
- Hastalıkların teşhisi
- Kontrollü Salım Sistemleri
- İlaçlar
- Tedavi
- Yapay organlar
- İmplantlar

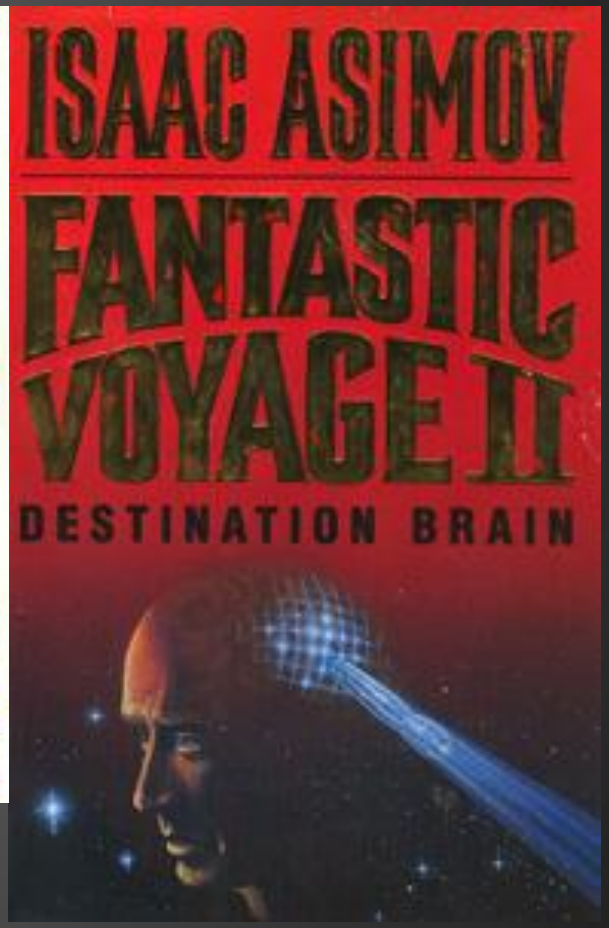






Fantastic Voyage- Esrarengiz Yolculuk (1966)



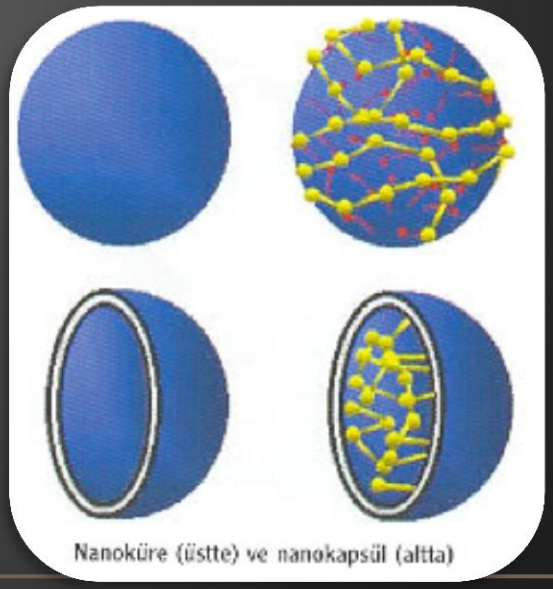


- AMELİYAT YAPABİLEN, VÜCUDA ENJEKTE EDİLECEK NANOROBOT GELİŞTİRİLDİ Avustralya'nın Clayton kentindeki Monash Üniversitesi, Nanofizik Laboratuvarı yetkililerinden James Friend , insan vücudundaki atardamarlar için bir nanorobot üzerinde araştırma yaptıklarını söyledi. Bilim adamlarının 250 nanometre çapında bir nanorobot geliştirdiklerini belirten Friend, nanorobotun büyüklüğünün yaklaşık 2-3 saç teli kalınlığında olduğunu kaydetti. Friend, robotun motoruna Proteus isminin verildiğini, bu ismi verirken 1966'da çevrilen "Fantastik Yolculuk" (Fantastic Voyage) filminden esinlendiklerini anlattı.

NANOTIP

- Teşhis ve tedavi amaçlı nanorobotlar.
- Dolaşım sistemindeki zararlı maddelerin temizlenmesi.
- Hasarlı dokulara oksijen sağlanması.
- Çeşitli hastalıkların izlenmesi ve teşhisi.
- Bakteri ve virüs enfeksiyonlarının tedavi edilmesi.

- Kanser hücrelerinin saptanıp yok edilmesi. ALTIN NANOPARTİKULLAR VB.
- Nanokürelerle ilaç salımı.
- Doku yapılanmasını gerçekleştirecek nanoteknolojik tasarıma dayalı doku iskeleleri.



Nanoküre (üstte) ve nanokapsül (altta)

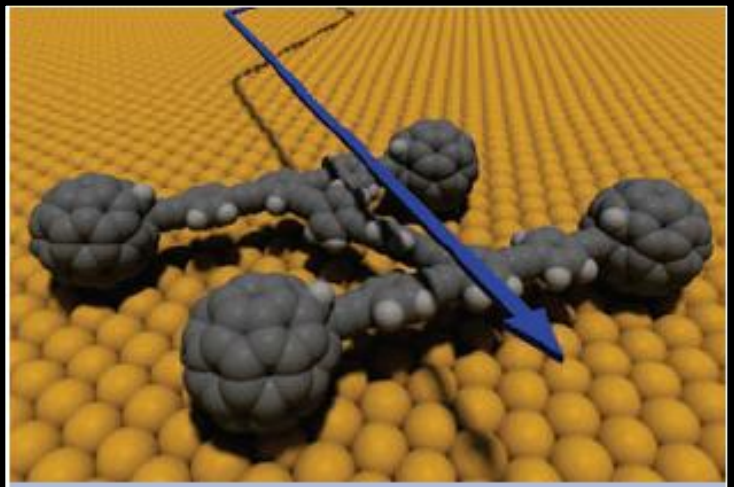
Enerji

Hidrojen Depolama: Geçiş elementleri (Pt, Pd, Ti, V,...) ile işlevleştirilen nanotüpler ve moleküllere çok yüksek kapasitede hidrojen depolanabilir.

Geleceğin Hidrojen ile çalışan arabaları

Malzemeler

- Su ve Kir Tutmayan Yüzeyler
- Çizilmeye karşı etkili ve parlak boya
- Su itici, kir tutmayan, kolay temizlenen ayna ve camlar
- Nanofiltreli klimalar
- Yosun ve deniz hayvanlarının tutunamadığı boyalar ve yüzeyler

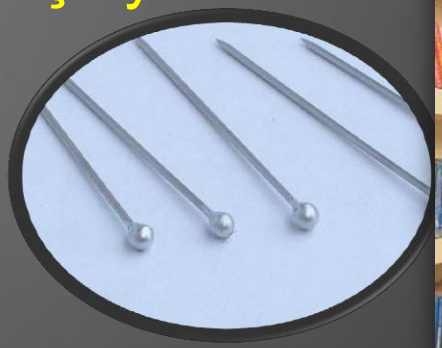


En Küçük Araba

Rice Üniversitesi (ABD) araştırmacıları, şasi ve dingilleri organik bileşenlerden, tekerlekleri de buckyball denen küre biçimli karbon-60 moleküllerinden oluşan, süspansiyon-sistemine serbestçe dönen akslara sahip bir nano-araba yaptılar. Arabanın boyutları yalnızca 3-4 nanometre. İnsan saçının çapıysa yaklaşık 80.000 nanometre. Tekerleklerin bir tarayıcı tünelleme mikroskopunun ucunun çektiği yönde rahatça döndükleri açıklandı.

Kuramsal olarak toplu iğnenin başında, Britanica Ansiklopedisinin tamamını yazacak kadar boşluk olduğunu gösteriyor,

120,000 cilt kitabın, sadece 1 tek ince kütüphane kartına yazılabileceğini tartışılıyor



Tekstil

Nanoteknolojik Kumaşlar

- Özel polimerler sayesinde terin emilip vücudun kuru kalmasını sağlayan, su tutmayan giysiler
- Dokumada kullanılacak elektronik fiberler sayesinde İstenildiğinde renk değiştirebilen
- Vücudu zararlı ışınlardan koruyan, Güneş enerjisinden elektrik üreterek yazın soğutan, kışın ısıtabilen giysiler

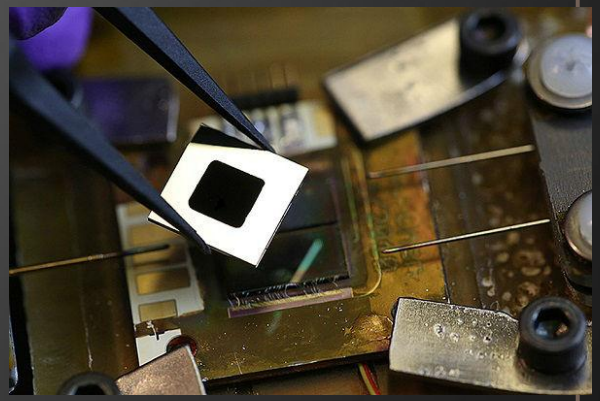
TEKSTİL

- Gören, duyan ve hisseden kumaşlar.
- Akıllı üniforma
- Akıllı üniforma askerin yaralandığını ve sağlık durumunu merkeze bildiriyor
- Leke tutmayan, kolay ütülenen ve çabuk kuruyan akıllı kumaşlar.

Süper asker: Bir asker düşünün; üzerine giydiği akıllı üniforma, düşman askeri lazer silahıyla nişan aldığında haber verecek, enerjiye ihtiyacı olduğunda güneş pili gibi çalışacak, zehirli biyolojik ve kimyasal gazları tesbit edecek, ve gece karanlığında kendi askeri tarafından tanınabilecek, ama aynı zamanda çok hafif ve ucuz olacak. Eskiden yanlızca filmlerde tanık olduğumuz bu akıllı elbiselerin yakın bir gelecekte kullanılmaya başlanılması bekleniyor.

NANOFOTONİK

- Boyutları 1-100 nm arasında değişen nano yapıların ışıkla etkileşimini inceler. Bu boyutlarda tek bir atomun ya da molekülün tek bir fotonla etkileşimi söz konusudur.
- Bilginin optik olarak nanofotonik kristaller aracılığıyla taşınması sağlanarak, bilgisayarların yüzlerce kat daha hızlı çalışması sağlanabilecektir. Aynı şekilde internet hızının da yüzlerce kat artması bu sayede gerçekleştirilecektir.



Nanoteknolojinin araçları, alet ve yardımcıları

- Nano teknolojinin araştırılmasında, ürünlerin ve sistemlerin kontrolünde kullanılan en önemli araçları taramalı prob mikroskopları, özellikle atomik kuvvet mikroskobu ve taramalı tünelleme mikroskobudur. Nano teknolojideki gelişim, prob mikroskoplarının gelişimini hızlandırdığı, kullanımını yaygınlaştırdığı gibi, bu cihazları nanomaniplatör olarak (mikrorobot) kullanarak nano teknolojinin uygulanmasını artırıcı etki yapmıştır. Bu yönde özellikle biyolojik ve bilimsel uygulamalar yaygınlaşmaktadır.

TÜRKİYE’ DE NANOTEKNOLOJİ

Türkiye’de nanoteknoloji araştırmalarının çoğu kuramsal ve bireysel düzeydedir.

Avrupa Birliğinin 6.ve 7 Çerçeve Programı ile Horizon 2020 sayesinde nanoteknoloji araştırmaları yeniden yapılanma ve ivme kazanmış bulunmaktadır.

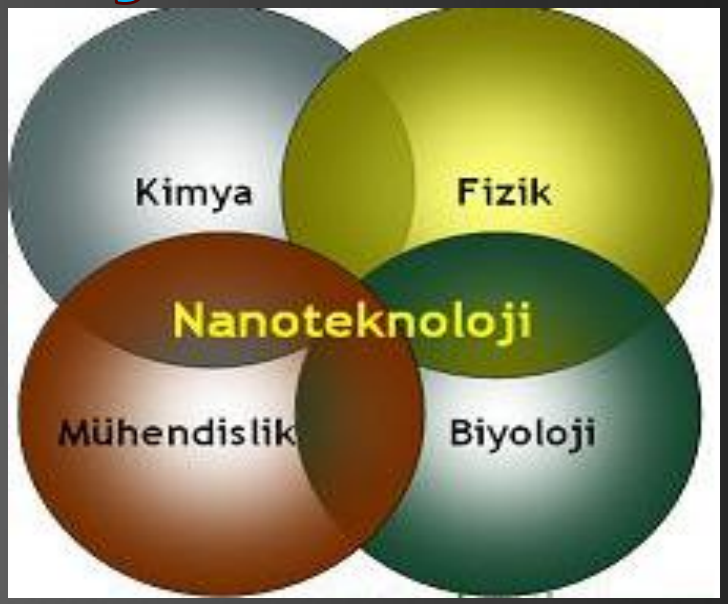
TÜBİTAK tarafından hazırlanan Vizyon2023 Programı’na öncelikli alanlardan biri olarak alınmış bulunmaktadır.

Ulusal Nanoteknoloji Araştırma Projesi nanoteknolojiyi geliştirmek ve uzman yetiştirmek amacıyla hazırlanmıştır.

Farklı üniversitelerde Nanoteknoloji araştırma merkezlerinin kurulması (Bilkent, Sabancı, Ege, Erciyes Üniversitesi vd.)

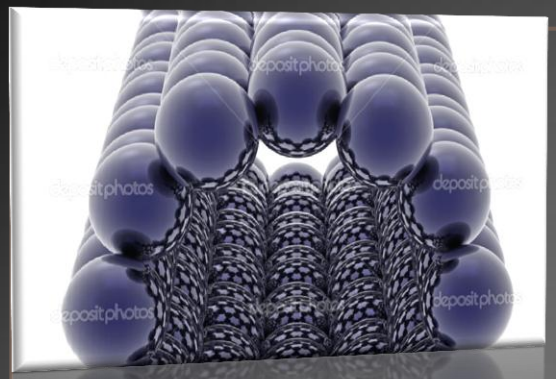
Nanoteknoloji ve Kimya

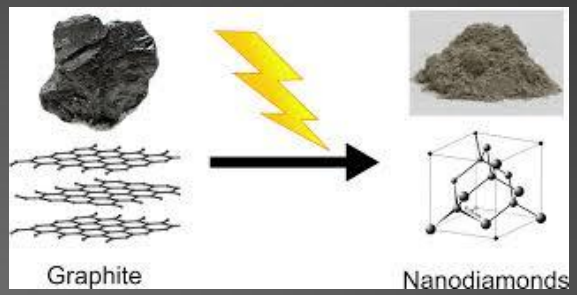
Kimyasal tepkimelerin kontrolü, kinetiği, akıllı moleküllerle kimyasal tepkimelerin yönlendirilmesi, biyokatalitik (enzimatik) olayların yönlendirilmesi, kristal düzeni, kristal yapı hataları ve bunlardan yararlanma, yüzey kimyası ve yüzeyin araştırılması, bu tekniklere uygun analiz ve kontrol tekniklerinin geliştirilmesi çağımız kimyacılarını, özellikle analitik kimyacıları nanoteknolojiye de yönelmeye zorlamıştır.



Kimyada Nanomalzeme Hazırlama

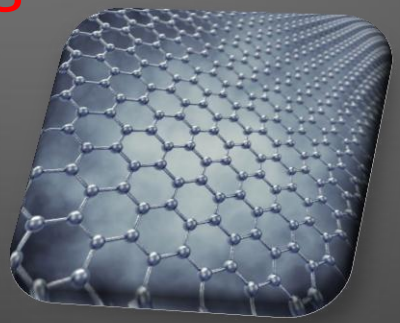
- ✓ Katı Hal Yöntemleri
- ✓ Öğütme
- ✓ Frezeleme
- ✓ Mekanik Alaşımlama Teknikleri
- ✓ Buhar Yöntemleri
- ✓ Kimyasal Sentez / Çözelti Yöntemler
- ✓ Sol-jel Yöntemi
- ✓ Kolloid Kimyası
- ✓ Gaz Fazda Sentez Yöntemleri

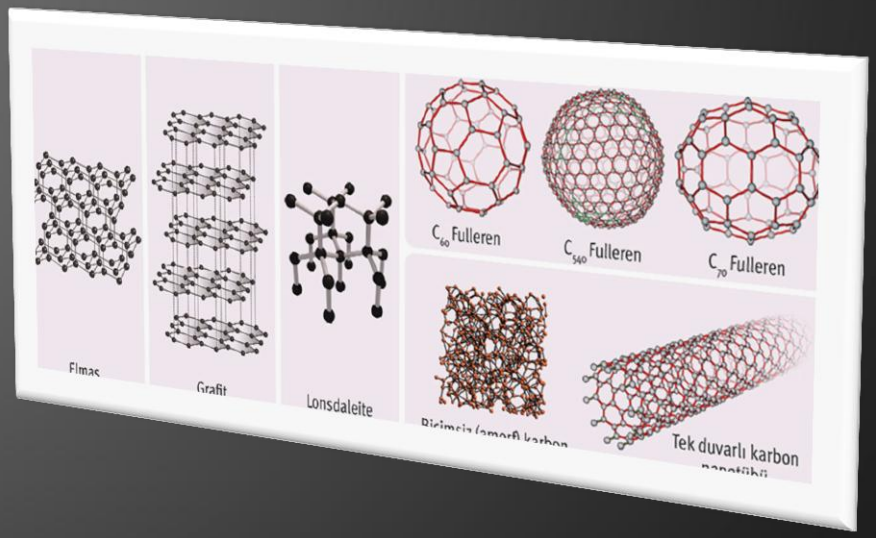




NANOTEKNOLOJİK GELİŞMELERDE KARBON TEMELLİ NANO MALZEMELER

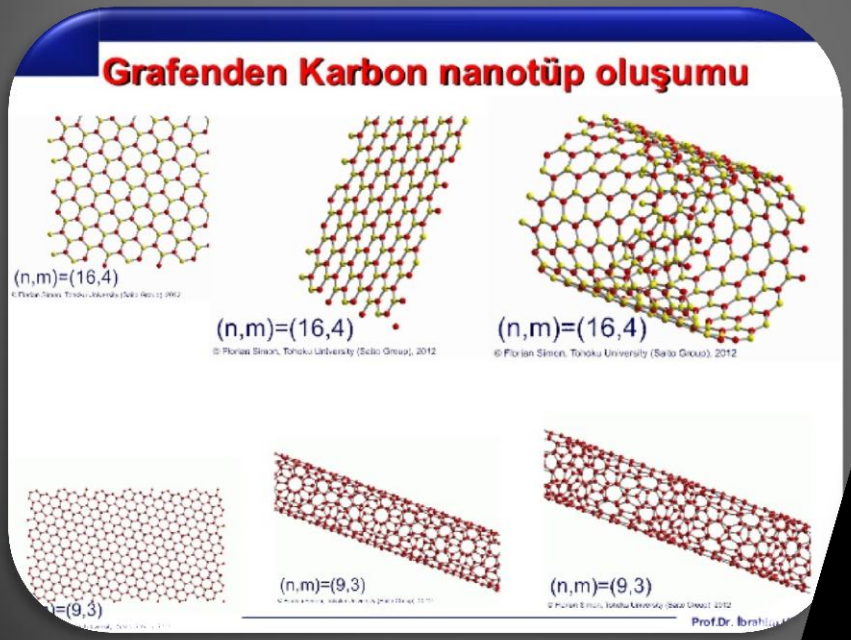
- Karbon nanotüp (tek duvarlı, çift duvarlı, çok duvarlı ve fulleren)
- Grafen ve grafen oksit
- Nano elmas

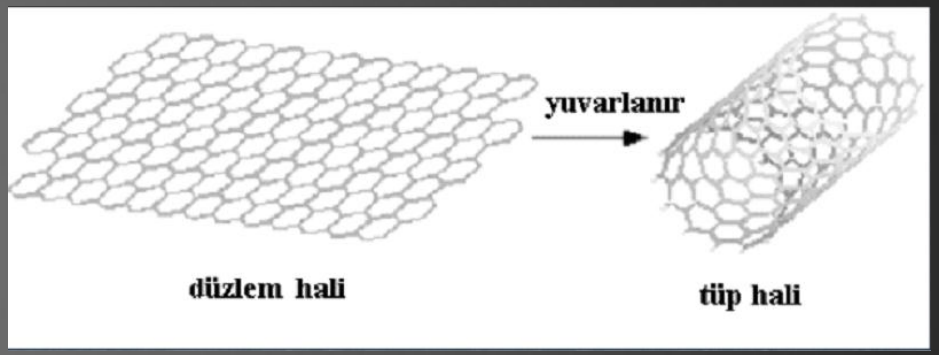


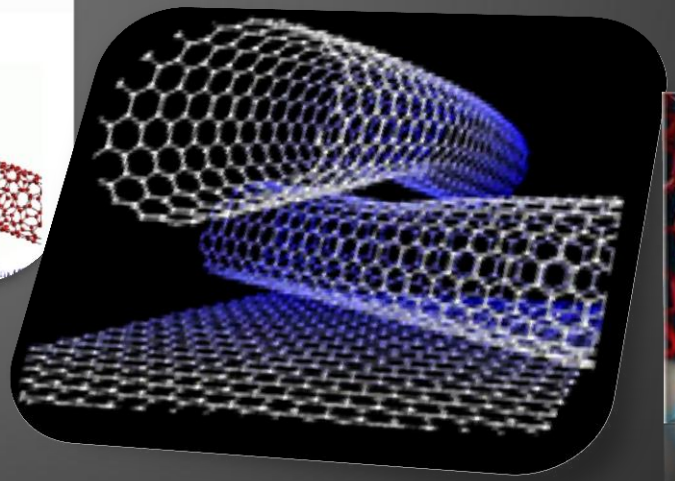


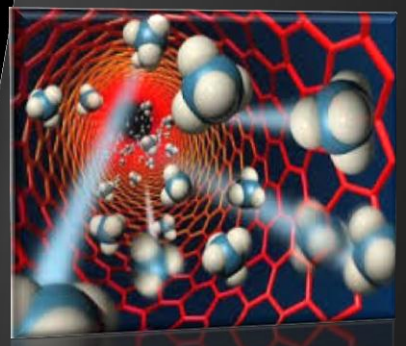
Karbon-Nanotüpler

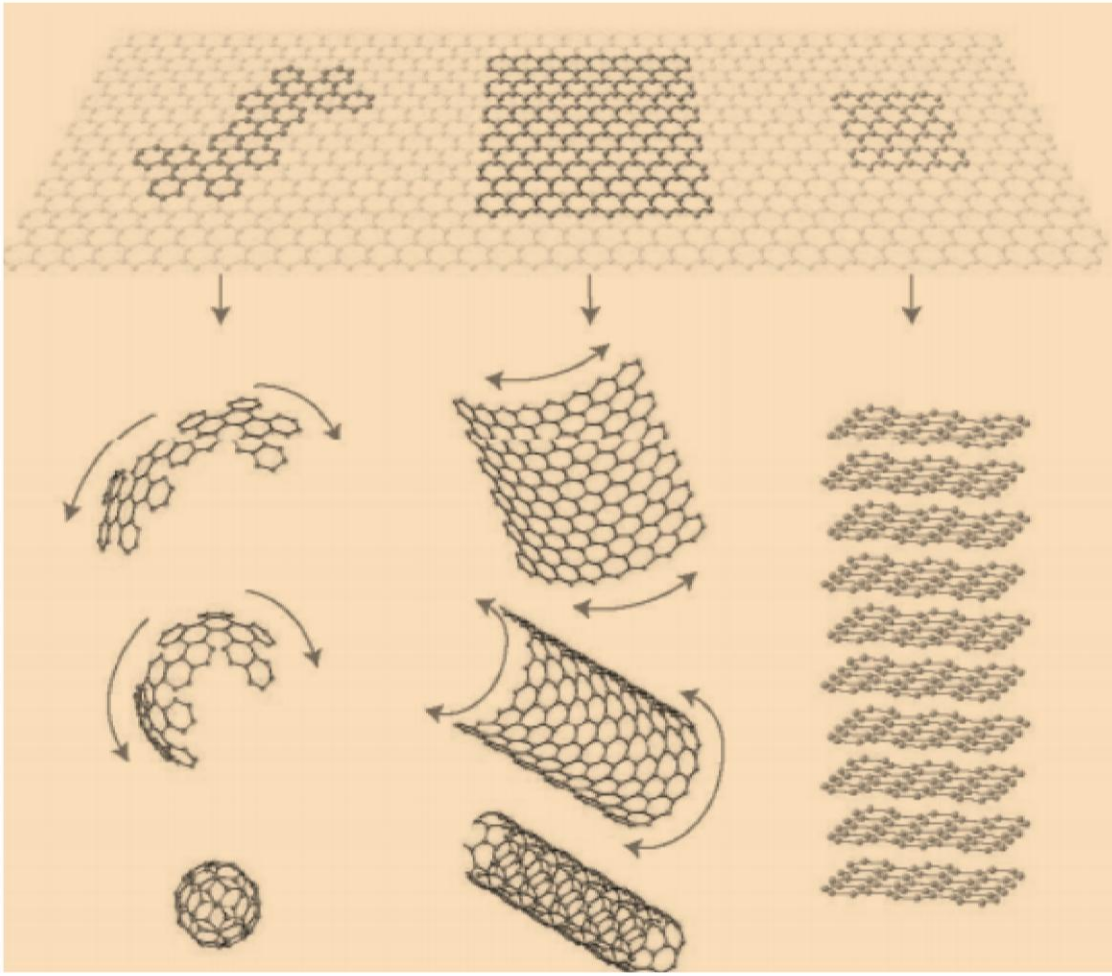
Karbon nanotüpler grafen düzlemi örülü yapının bir silindir şekline sarılması ve uçlarının küresel bir silindir kapağı şeklinde kapatılmasıyla oluşturulan silindirik yapılardır.









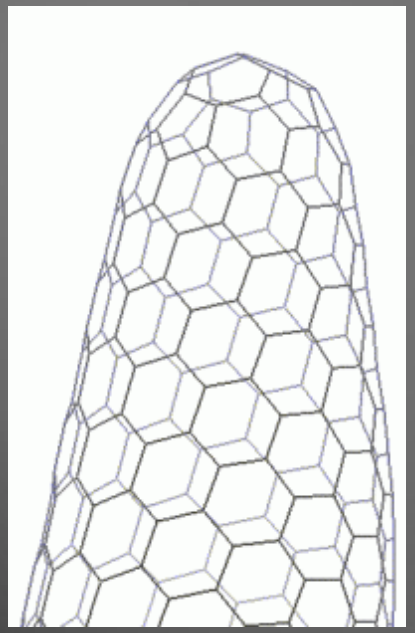


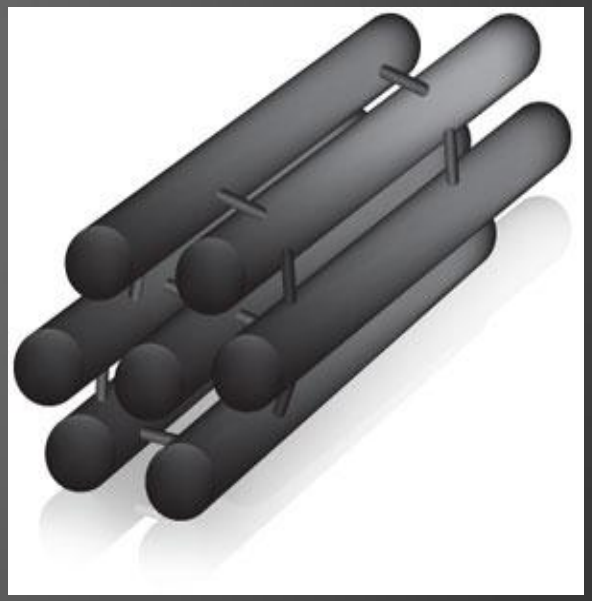
Tek tabakalı grafit yapısı olan grafen başlangıç maddesinden elde edilen;60 karbon atomuna sahip futbol topu şeklindeki yapılara fulleren,boru şeklinde katlanmasıyla oluşan yapılara karbon nanotüp denir.

- Nanohorn
- Nanoboynuz

nanocages

nanokafes





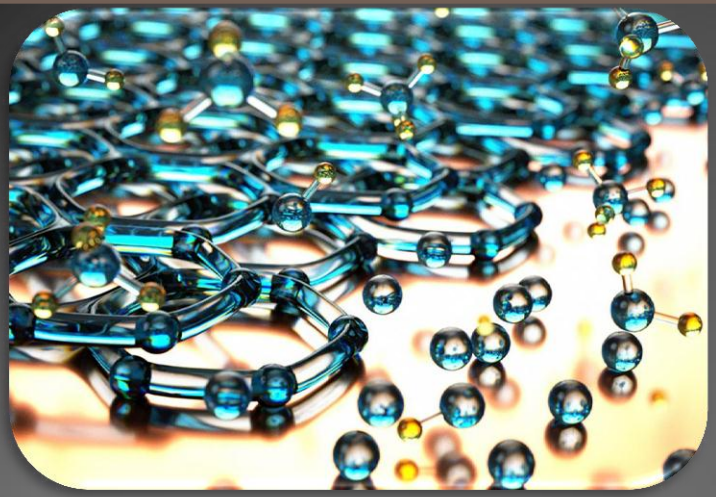
theor.jinr.ru/disorder/nano.html

http://www.co2crc.com.au/aboutgeo/cap_adsorption.html

KARBON NANOTÜPLERİN ÖZELLİKLERİ

- Bağ tipi polar olmadığı için, nanotüpler suda çözünemezler.
- Genellikle kimyasal müdahaleler olmadığı sürece çözünemezler.
- TDKN'ler toluen, dimetil formamit ve tetrahidrofuran gibi organik çözücüler ile kararlı çözeltiler oluşturabilir.
- Vakumda 1500 ^{o}C'ye, açık havada ise 750 ^{o}C'ye kadar kararlı halde durabilirler.
- Yüzey alanı-hacim oranı yüksektir.

Elektronik
Nanoteknoloji
Enerji (Yakıt hücreleri gaz depolama, pil, kapasitör)
Karbon nanotüplerin kullanım alanları
Kompozit malzemeler
(Elektik ileten plastikler
Kuvvetlendirilmiş malzemeler)
Kimya (Adsorbent, Sensör, Katalizör



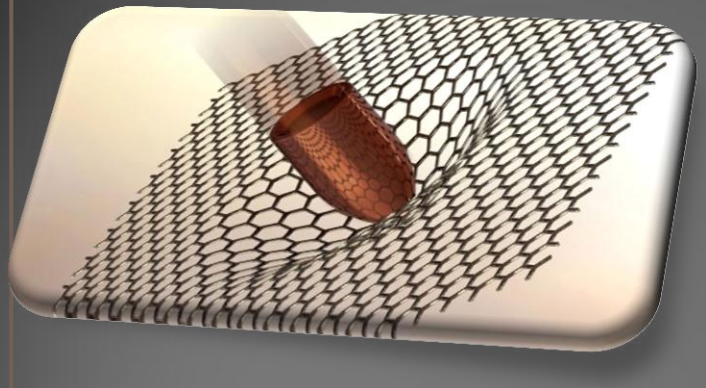
Nobel Fizik Ödüllü : Grafen

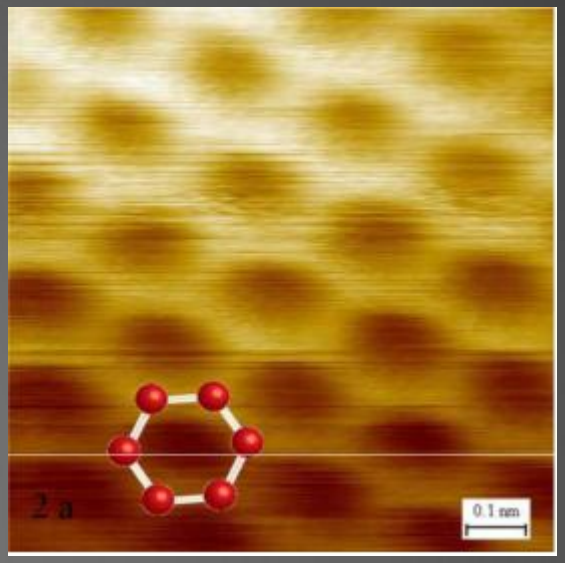
Grafen, karbon atomunun bal peteği örgülü yapılarından bir tanesine verilen isimdir. Günlük hayatta kurşun kalemlerde, pillerde ve elektrik motoru fırçalarında bulunur. Kurşun kalemlerin içindeki grafit, grafen tabakalarının üst üste binmesinden oluşur.

2010 yılında Nobel Fizik Ödülü, bilgisayar işlemcilerini inanılmaz hızlara çıkarma potansiyeli olan grafenle ilgili çalışmaları nedeniyle Hollandalı Andre Geim ve Rus kökenli İngiliz vatandaşı Konstantin Novoselov‘ a verildi.

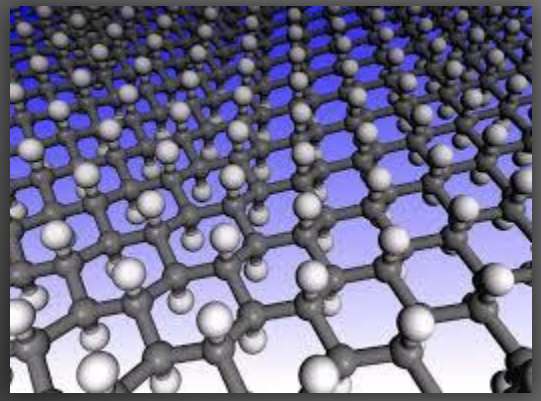
.

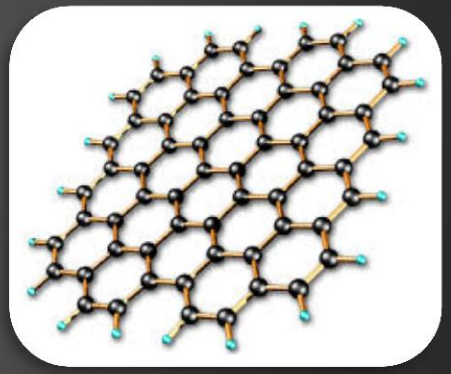
Grafen 6 karbonlu bal peteği görünümünde benzen halkalarından oluşur.

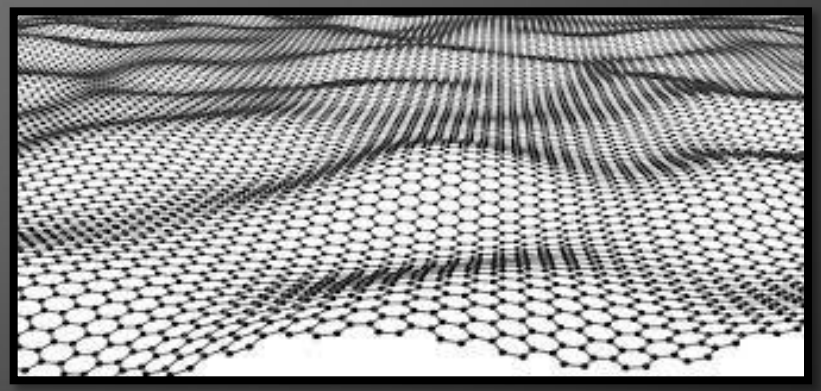




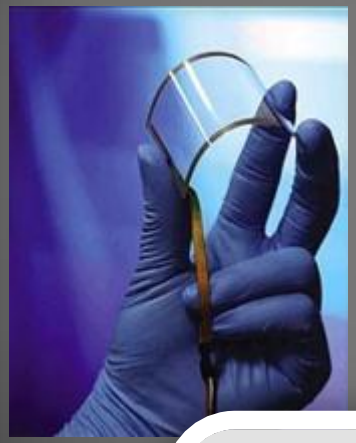
Grafenin TEM görüntüsü

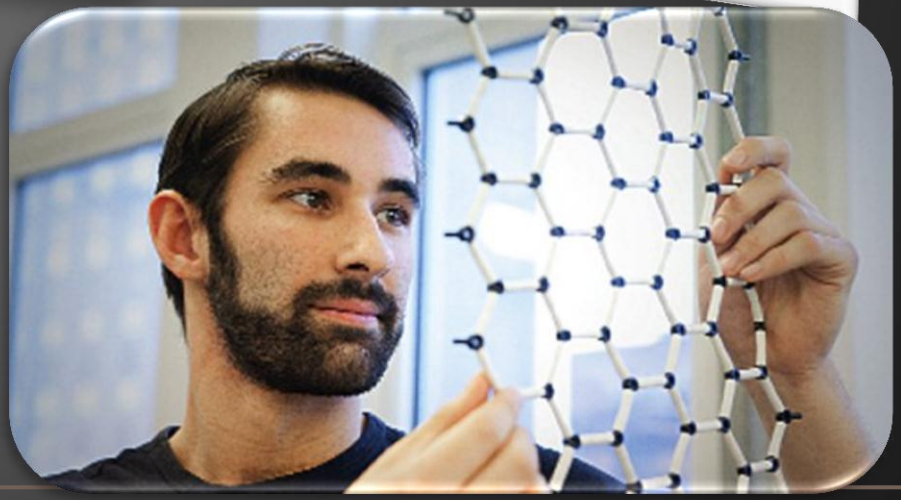






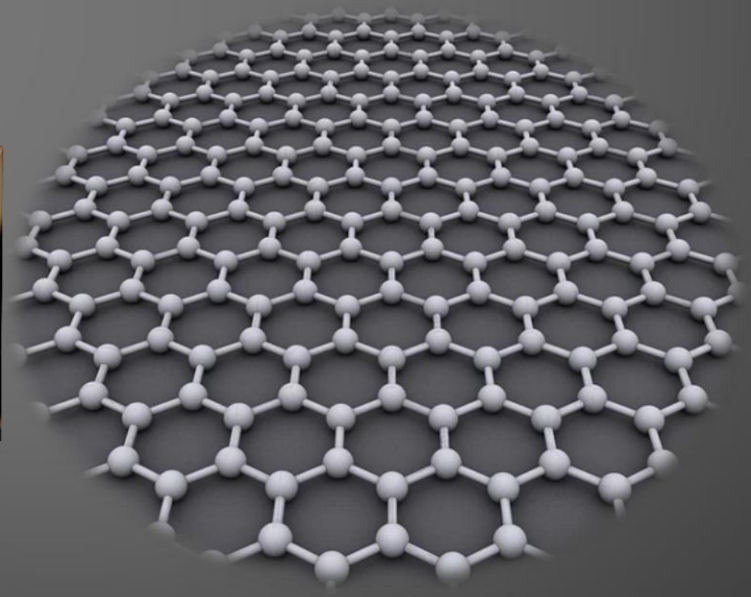
Grafenin kullanım alanları için ‘kullananın keyfine kalmıştır’ demek yanlış olmaz çünkü grafen isteğinize göre; sağlamdır, hafiftir, süper iletkendir, esnektir veya çok serttir, kimyasal değişime de uygundur. Grafendeki güçlü karbon bağları ona yeryüzündeki bilinen en sağlam malzemelerden biri olma özelliğini kazandırmıştır





Elektronlar Grafende Çok Yüksek Hızla Hareket Ediyor

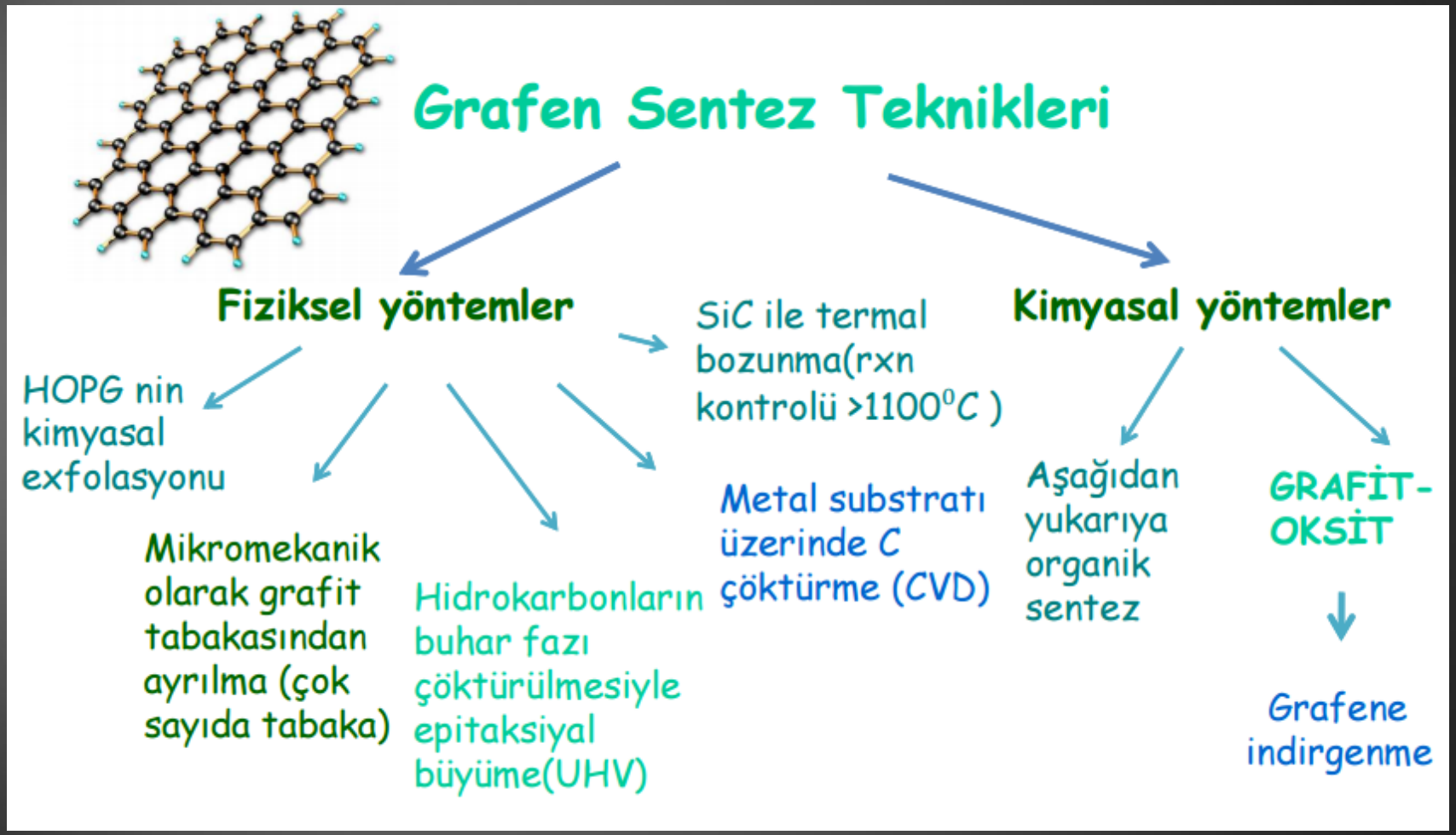
Karbon atomlarının iki boyutlu altıgen bir yapıda dizilmiş bu formu, doğada iki boyutlu tek malzeme örneğini oluşturmasının yanı sıra, grafene olağanüstü özelliklerini de kazandırıyor. Elektronlar bu tek atom kalınlığındaki karbon tabakası içerisinde sanki hiç kütleleri yokmuşçasına hızlı hareket ediyor, kaplarına sığamıyorlar.



Grafen' in Kullanıldığı alanlar

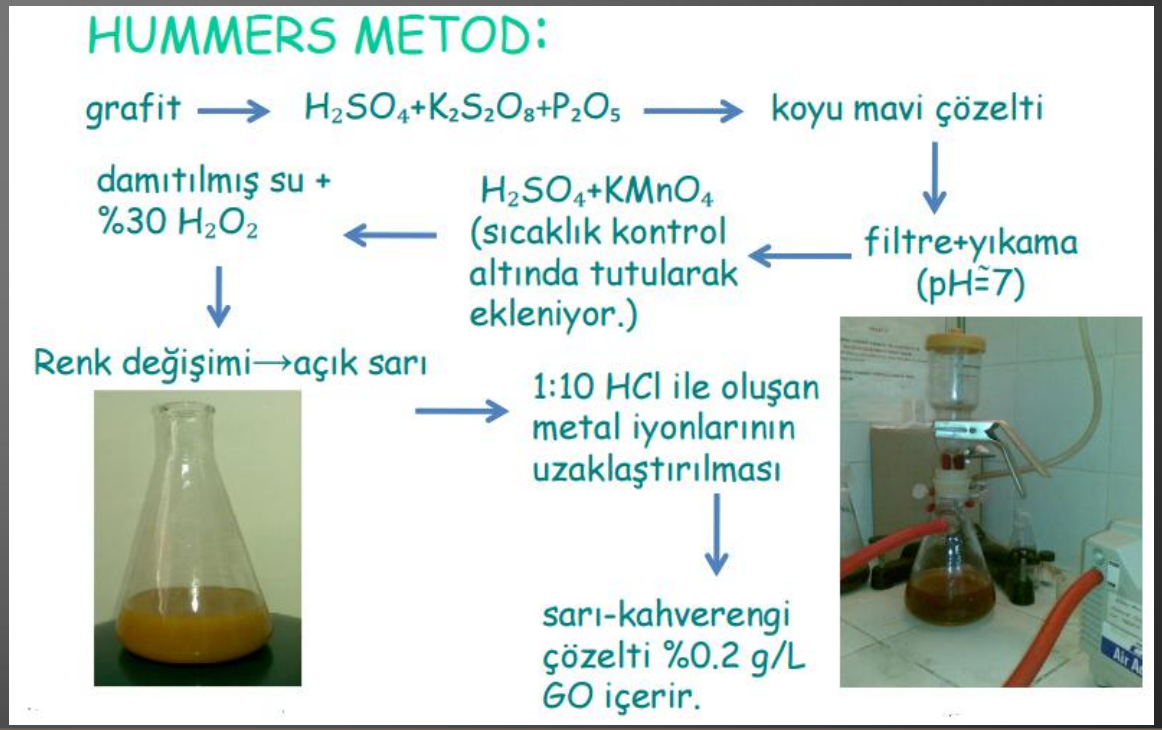
- Şeffaf iletken elektrodlar
- Kompozit materyali (özellikle uçak endüstrisi; düşük ağırlık, yüksek direnç)
- Hidrojen depolama
- Yakıt hücreleri
- Entegre devre komponenti
- Adsorbent
- Katalizör destek malzemesi
- Isı transfer malzemesi
- Bataryalar(şarj ömrü çok uzun süper pil malzemesi)
- Kapasitörler(elektrik depo eden ultra kapasitörler)

Grafen Sentez Teknikleri



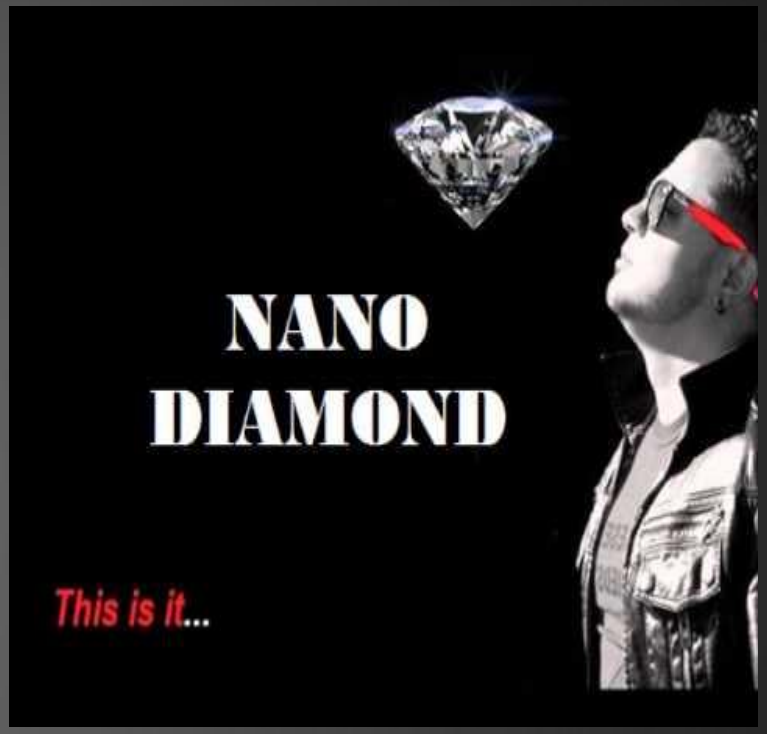
Grafen-Grafen Oksit Sentez Yöntemi (Modifiye hummers methodu)

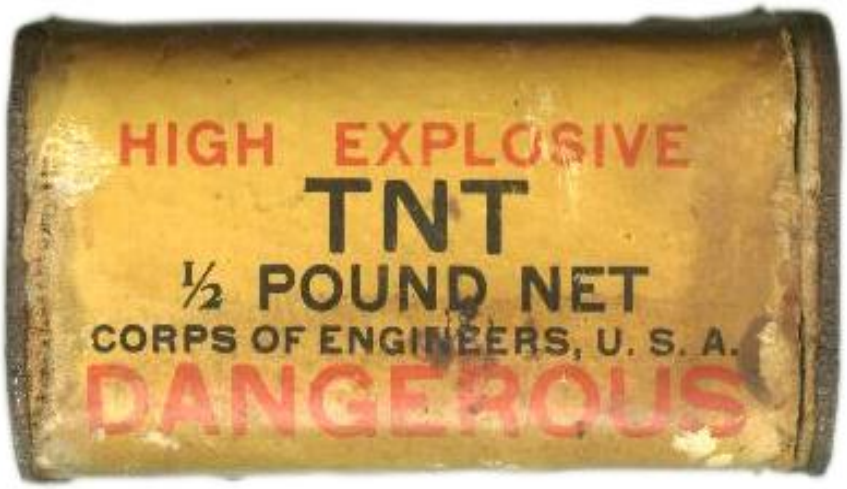
Hummers metoduyla sentezlenen grafit oksit tabakaları sonikasyon işlemiyle biribirinden ayrılıyor. Birbirinden ayrılan tabakalar; 1)termal anneal 2) kimyasal yöntemlerle indirgenmeye bırakılıyor ve grafen elde ediliyor



Nano elmas

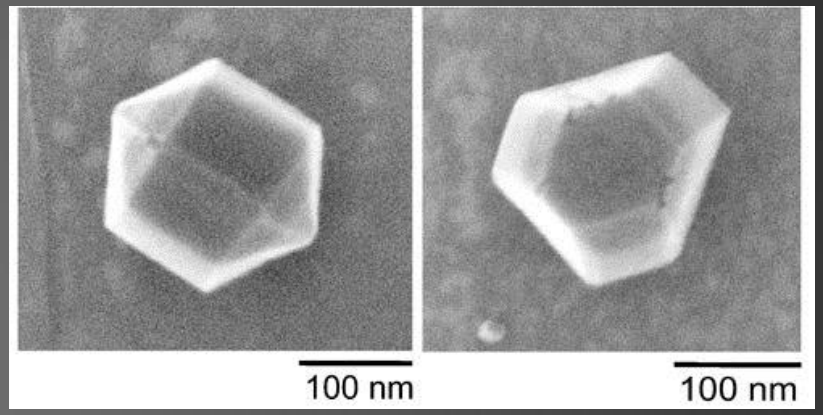
Nano elmas parçacıkları küresel yapısı, süper sertliği, mükemmel ısı iletkenliği, kimyasal kararlılığı, optik özelliği ve elektriksel yalıtkanlığı ile eşsiz bir nanoteknolojik malzemedir. Kullanıldığı alanlarda, dahil edildiği yapı veya uygulama alanlarında mükemmel özellikler sağlamaktadır.




HIGH EXPLOSIVE
TNT
½ POUND NET
CORPS OF ENGINEERS, U. S. A.
DANGEROUS

Nano elmas;

- Uzay-havacılık uygulamaları
- Makine sanayi
- Otomotiv endüstrisi
- Metal sanayi
- Plastik sanayi
- Parlatma ve yağlama endüstrileri gibi bir çok sahada geniş kullanım alanına sahiptir.

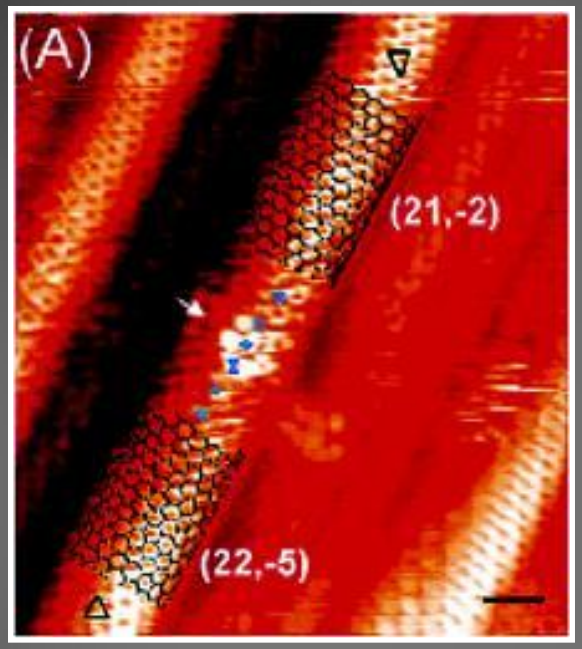


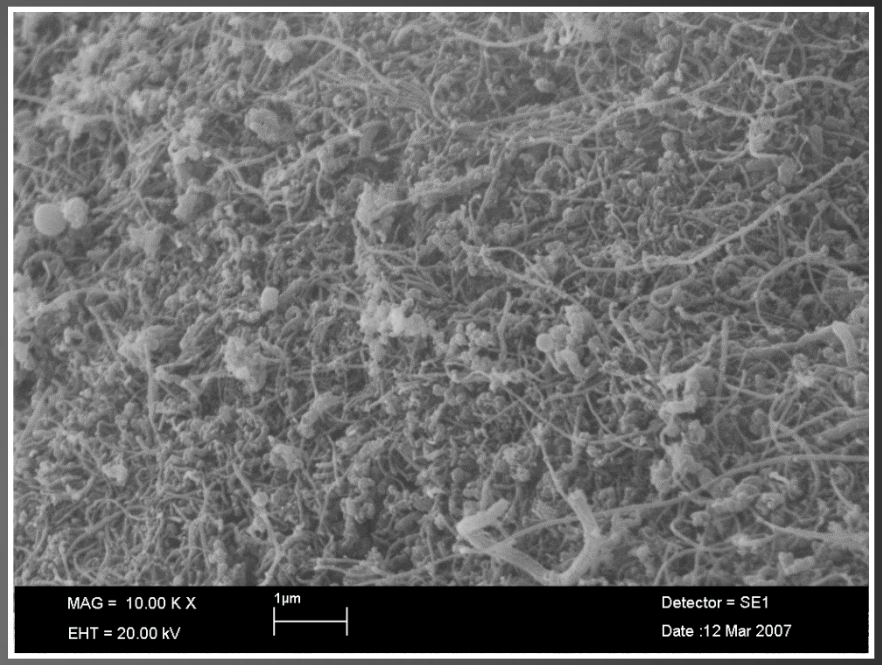
Nano materyallerin Analitik Uygulamalarda Kullanımları

Avantajları;

- ✓ Yüksek adsorpsiyon kapasitesi
- ✓ Geniş yüzey alanı
- ✓ Fiziksel kararlılık
- ✓ Kimyasal kararlılık
- ✓ Modifikasyon elverişliliği

Adsorban Olarak Karbon Nanotüpler





- Scanning Tunnelling Microscopy (STM)

Çok duvarlı bir karbon-nanotüpün SEM fotoğrafı

M. Tuzen, K.O. Saygı, M. Soylak, Solid Phase Extraction of Heavy Metal Ions in Environmental Samples on Multiwalled Carbon Nanotubes, *Journal of Hazardous Materials,* 152, 632-639 (2008).

Available online at www.sciencedirect.com
ScienceDirect
Journal of Hazardous Materials 152 (2008) 632–639
Journal of Hazardous Materials
www.elsevier.com/locate/jhazmat

Solid phase extraction of heavy metal ions in environmental samples on multiwalled carbon nanotubes

Mustafa Tuzen [a], Kadriye O. Saygi [a], Mustafa Soylak [b,*]

[a] *Gaziosmanpasa University, Faculty of Science and Arts, Chemistry Department, 60250 Tokat, Turkey*
[b] *Erciyes University, Faculty of Science and Arts, Chemistry Department, 38039 Kayseri, Turkey*

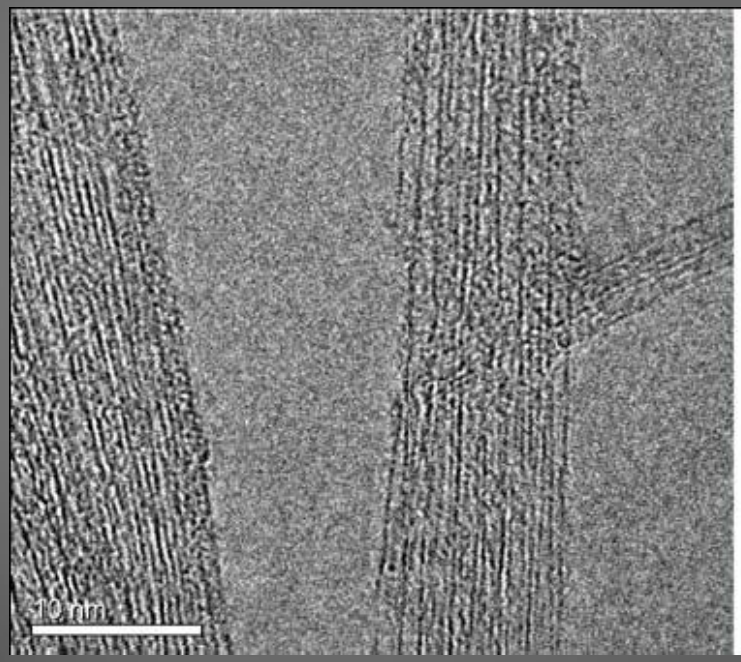
Received 22 December 2006; received in revised form 12 March 2007; accepted 11 July 2007
Available online 17 July 2007

Abstract

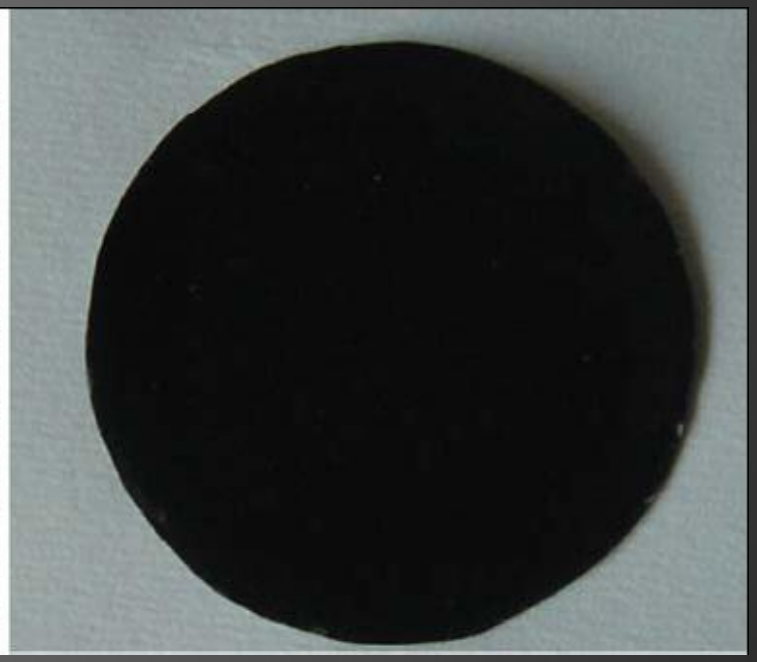
Multiwalled carbon nanotubes (MWNTs) were used as solid phase extractor for Cu(II), Cd(II), Pb(II), Zn(II), Ni(II) and Co(II) ions as ammonium pyrrolidine dithiocarbamate (APDC) chelates, in the present study. The influences of the experimental parameters including pH of the solutions, amounts of MWNTs, amounts of APDC, eluent type and volume, sample volume etc. on the quantitative recoveries of analyte ions were investigated. The effects of matrix ions of natural waters and some transition metals on the recoveries of the analyte ions were also examined in the model solutions. Tests of addition/recovery for analyte ions in real samples were performed with satisfactorily results. The detection limits (3 s) for the analyte ions were in the range of 0.30–0.60 $\mu g\,l^{-1}$. The concentrations of analytes in standard reference materials (NIST RM 8418 Wheat gluten, LGC 6010 Hard drinking water and NIST SRM 1515 Apple leaves) pretreated by the presented method were measured with FAAS and the analytical values were well agreed with the certified values and the reference values without the interference of major components. The presented method has been applied to the determination of analytes in food and environmental samples with satisfactory results.
© 2007 Elsevier B.V. All rights reserved.

Keywords: Multiwalled carbon nanotubes; APDC; Metal ions; Solid phase extraction; Atomic absorption spectrometry

Karbon nanotüp Filtreler



Tek duvarlı karbon nanotüp filtrenin SEM görüntüsü



CNT filtrenin fotoğrafı

Food and Chemical Toxicology 48 (2010) 1511–1515

Contents lists available at ScienceDirect

Food and Chemical Toxicology

journal homepage: www.elsevier.com/locate/foodchemtox

Chromium and iron determinations in food and herbal plant samples by atomic absorption spectrometry after solid phase extraction on single-walled carbon nanotubes (SWCNTs) disk

Mustafa Soylak *, Yunus Emre Unsal

University of Erciyes, Faculty of Science and Arts, Chemistry Department, 38039 Kayseri, Turkey

ARTICLE INFO

Article history:
Received 3 December 2009
Accepted 15 March 2010

Keywords:
Single-walled carbon nanotubes disk
Preconcentration
Separation
Atomic absorption spectrometry
Food

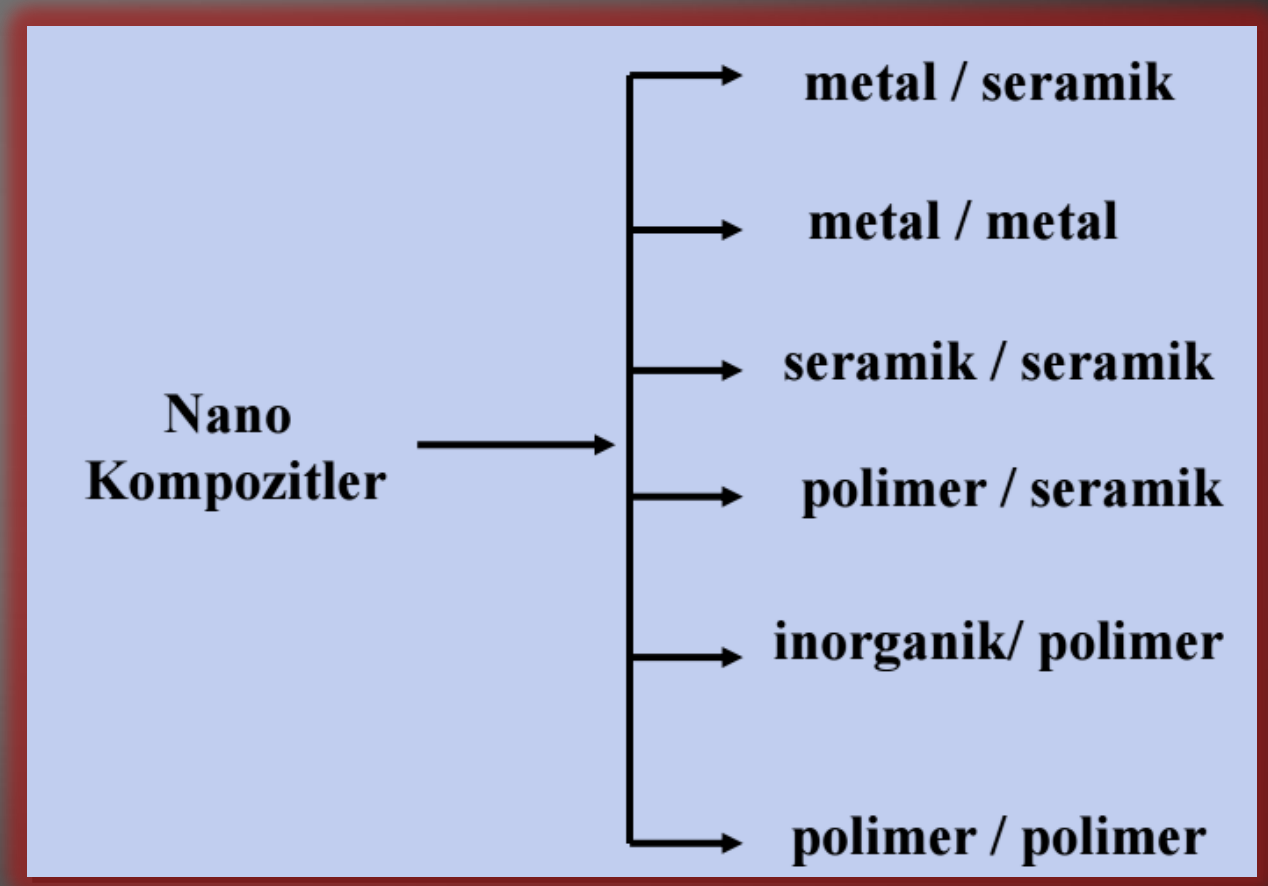
ABSTRACT

A preconcentration–separation procedure has been established based on solid phase extraction of Fe(III) and Cr(III) on single-walled carbon nanotubes (SWCNTs) disk. The analyte ions were quantitatively recovered at pH 8.0 on single-walled carbon nanotubes disk that contains 30 mg of nanotube. The influences of matrix components were tolerable. The detection limits for iron and chromium were calculated as 2.12 and 4.08 μg/l, respectively. The presented method was validated by the analysis of lichen (IAEA-336), CRM025-050 Metals on soil and BCR-032 Moroccan Phosphate rock certified reference materials. The method was successfully applied to the preconcentration and separation of iron and chromium in some food and herbal plant samples from Turkey.

© 2010 Elsevier Ltd. All rights reserved.

Nanokompozitler

Nano kompozitler, bir matris içerisinde nanometre büyüklüğünde parçacıkların dağılması ile oluşan malzemelerdir.



Talanta 119 (2014) 447–451

Contents lists available at ScienceDirect

Talanta

journal homepage: www.elsevier.com/locate/talanta

Polypyrrole/multi-walled carbon nanotube composite for the solid phase extraction of lead(II) in water samples

Ertugrul Sahmetlioglu [a], Erkan Yilmaz [b], Ece Aktas [a], Mustafa Soylak [b,*]

[a] Nigde University, Faculty of Sciences and Arts, Chemistry Department, 51100 Nigde, Turkey
[b] Erciyes University, Faculty of Sciences, Chemistry Department, 38039 Kayseri, Turkey

ARTICLE INFO

Article history:
Received 14 August 2013
Received in revised form
10 November 2013
Accepted 15 November 2013
Available online 27 November 2013

Keywords:
Conducting polymer
Multi-walled carbon nanotubes
Nanocomposite
Lead
Solid phase extraction

ABSTRACT

A multi-walled carbon nanotubes-polypyrrole conducting polymer nanocomposite has been synthesized, characterized and used for the separation and preconcentration of lead at trace levels in water samples prior to its flame atomic absorption spectrometric detection. The analytical parameters like pH, sample volume, eluent, sample flow rate that were affected the retentions of lead(II) on the new nanocomposite were optimized. Matrix effects were also investigated. Limit of detection and preconcentration factors were 1.1 $\mu g\ L^{-1}$ and 200, respectively. The adsorption capacity of the nanocomposite was 25.0 mg lead(II) per gram composite. The validation of the method was checked by using SPS-WW2 Waste water Level 2 certified reference material. The method was applied to the determination of lead in water samples with satisfactory results.

© 2013 Elsevier B.V. All rights reserved.

Polipirol-Karbon Nanotüp Kompozitinin Sentezine ve Karakterizasyonu
FT-IR, SEM ve TGA Görüntüleri

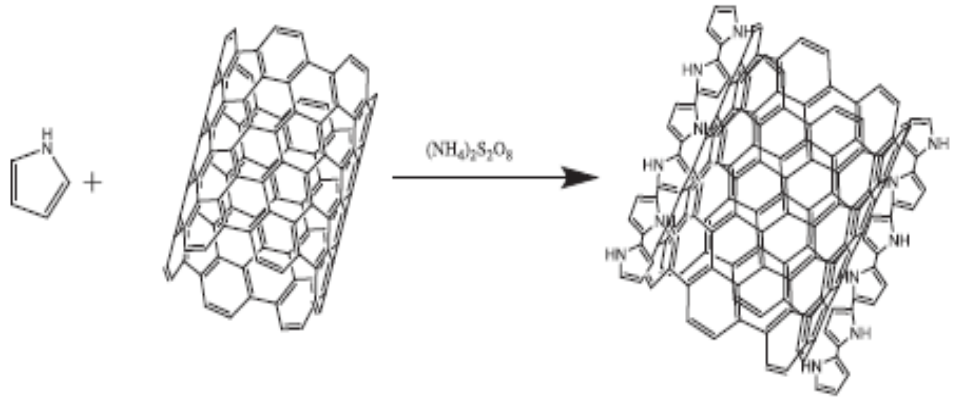


Fig. 1. Schematic structure of the nanocomposite.

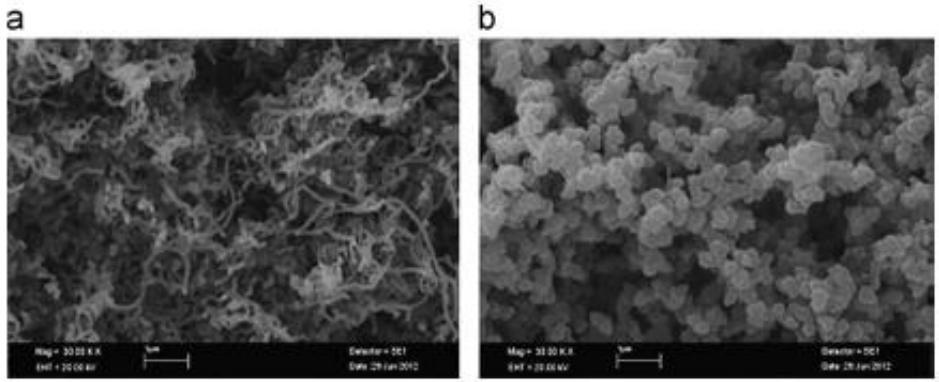


Fig. 2. SEM micrograph images. (a) Pristine MWCNT and (b) MWCNT-PPy nanocomposite.

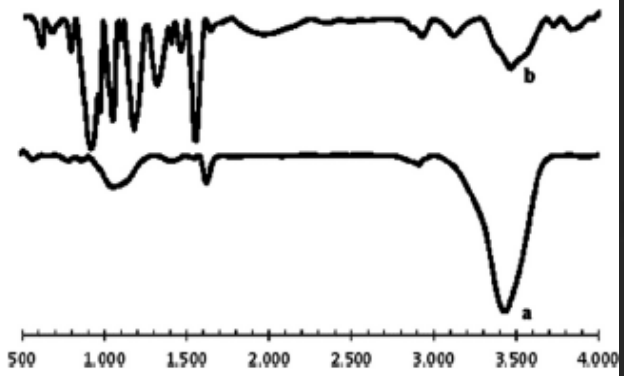


Fig. 3. FT-IR spectrums (a) pristine MWCNTs (b) FT-IR spectrum of MWCNT-PPy

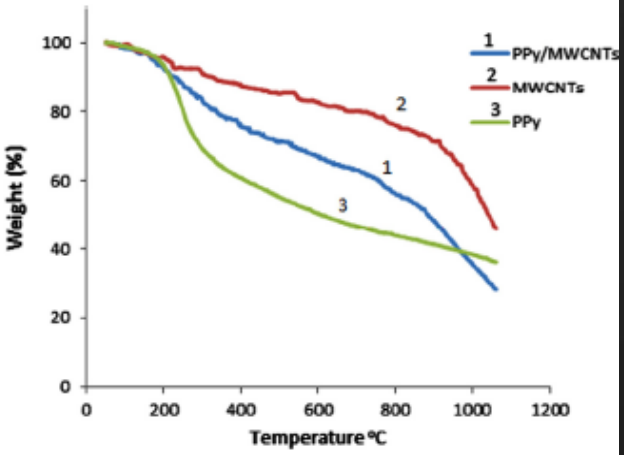


Fig. 4. TGA spectrums (1) MWCNT-PPy (2) MWCNTs (3) PPy.

Katı Faz Ekstraksiyonu Yöntemi

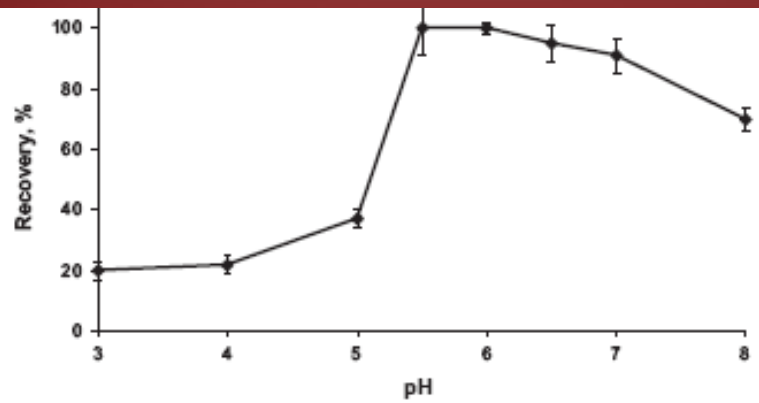


Fig. 5. Effect of pH on the recovery of lead(II) (Conditions: 0.4 μg mL^{-1} of lead(II), model solution volume; 50 mL, eluent: 10 mL of 3 mol L^{-1} nitric acid, amount of nanocomposite: 0.2 g, *N*: 3).

Table 1
Effect of eluent type on the recovery of lead(II) (pH: 6.0, concentration of lead(II): 0.4 μg mL^{-1} of lead(II), model solution volume: 50 mL, eluent flow rate: 2.0 mL min^{-1}, amount of nanocomposite: 0.2 g, *N*: 3).

Eluent solution	Eluent volume (mL)	Recovery (%)
1.0 M HNO_3	10	93 ± 8
2.0 M HNO_3	10	79 ± 6
3.0 M HNO_3	10	100 ± 2
1.0 M HCl	10	88 ± 3
2.0 M HCl	10	82 ± 5
3.0 M HCl	10	61 ± 4
1.0 M CH_3COOH	10	< 5
2.0 M CH_3COOH	10	< 5
3.0 M CH_3COOH	10	11 ± 0

Table 2
Tolerable levels of interfering ions on recovery of lead(II) (pH: 6.0, concentration of lead(II): 0.4 μg mL^{-1} of lead(II), model solution volume 50 mL, eluent: 10 mL of 3 mol L^{-1} nitric acid, amount of nanocomposite: 0.2 g, *N*: 3).

Ion	Tolerable concentration (μg mL^{-1})
K^+, Cl^-	10,000
Na^+	5000
Mg^{2+}, Ca^{2+}, SO_4^{2-}	2500
Ni^{2+}, Cd^{2+}, Cu^{2+}, Co^{2+}	10

Table 3
Recovery studies for the thermal water sample from Sivas and a mine waste water from Yozgat (pH: 6.0, eluent: 10 mL of 3 mol L^{-1} nitric acid, amount of nanocomposite: 0.2 g, *N*: 3).

Added (μg)	Thermal water from Sivas[a]		Mine waste water from Yozgat	
	Found (μg)	Recovery (%)	Found (μg)	Recovery (%)
0	BDL[b]	–	BDL	–
2.0	2.02 ± 0.02[c]	101	2.00 ± 0.14	100
4.0	4.01 ± 0.10	100	3.95 ± 0.10	99
10	10.13 ± 0.58	101	10.14 ± 0.57	101
25	25.80 ± 0.52	103	25.15 ± 1.71	101
30	30.30 ± 1.04	102	29.66 ± 2.76	99

[a] Properties of thermal water sample at the sampling: temperature: 45 °C, pH: 6.81, conductivity: 2750–3380 μs/cm.
[b] BDL: below of detection limit.
[c] Mean ± standard deviation.

Table 4
Analysis of lead(II) in water samples (pH: 6.0, concentration of lead(II): 0.4 μg m L^{-1} of lead(II), volume of water samples: 200 mL, final volume: 1 mL, amount of nanocomposite: 0.2 g, *N*: 3).

Samples	Concentration (μg mL^{-1})
Waste water I	2.16 ± 0.12[a]
Waste water II	0.10 ± 0.01
Well water	0.018 ± 0.0004

[a] Mean ± standard deviation.

Manyetik Nano Malzemeler

Manyetik nanoparçacıklar, son yıllarda özellikle biyomedikal ve biyoteknolojik uygulamalarda kullanılmalarına yönelik araştırmaların üzerinde yoğunlaştığı nano yapılı malzemeler arasında önemli bir yer edinmiştir. Manyetit (Fe_3O_4) gibi manyetik nanoparçacıkların çeşitli doğal ya da sentetik polimerlerle işlevsel hale getirilmesi yoluyla hazırlanabilen fonksiyonel manyetik nanoparçacıklar; manyetik rezonans görüntülemede, ilaç taşıma sistemlerinde, doku onarımında, tümörlerin ısı ile bozundurulmasında (hipertermi uygulamalarında), hücrelerin, RNA ve DNA gibi biyomoleküllerin biyolojik ortamlardan manyetik ayırma yöntemi ile ayrılmasında ve enzimlerin ve proteinlerin immobilizasyonunda destek materyal olarak kullanılmaktadırlar.

Manyetik destekler, nano materyallerin tepkime ve çözelti ortamından santrifüjleme, süzme gibi işlemlere gerek kalmadan, bir mıknatıs yardımıyla kolaylıkla uzaklaştırılabilmesini sağlarlar. Böylelikle, farklı uygulamaların daha pratik ve ekonomik hale gelmesine imkan verirler.

Aynı zamanda nano malzemelerin manyetik hale getirilmesi bu malzemelerin çözelti ortamında topaklaşmasını engeller.

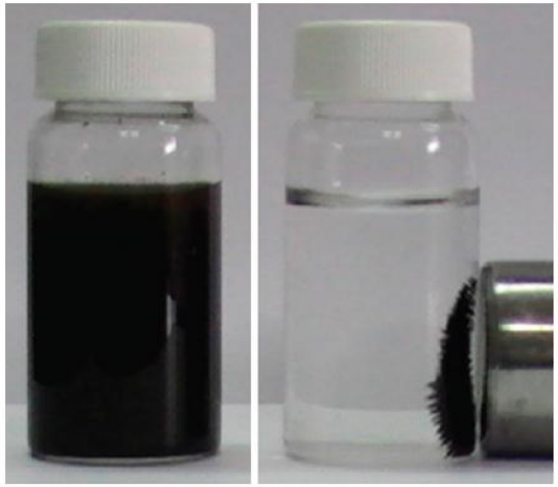
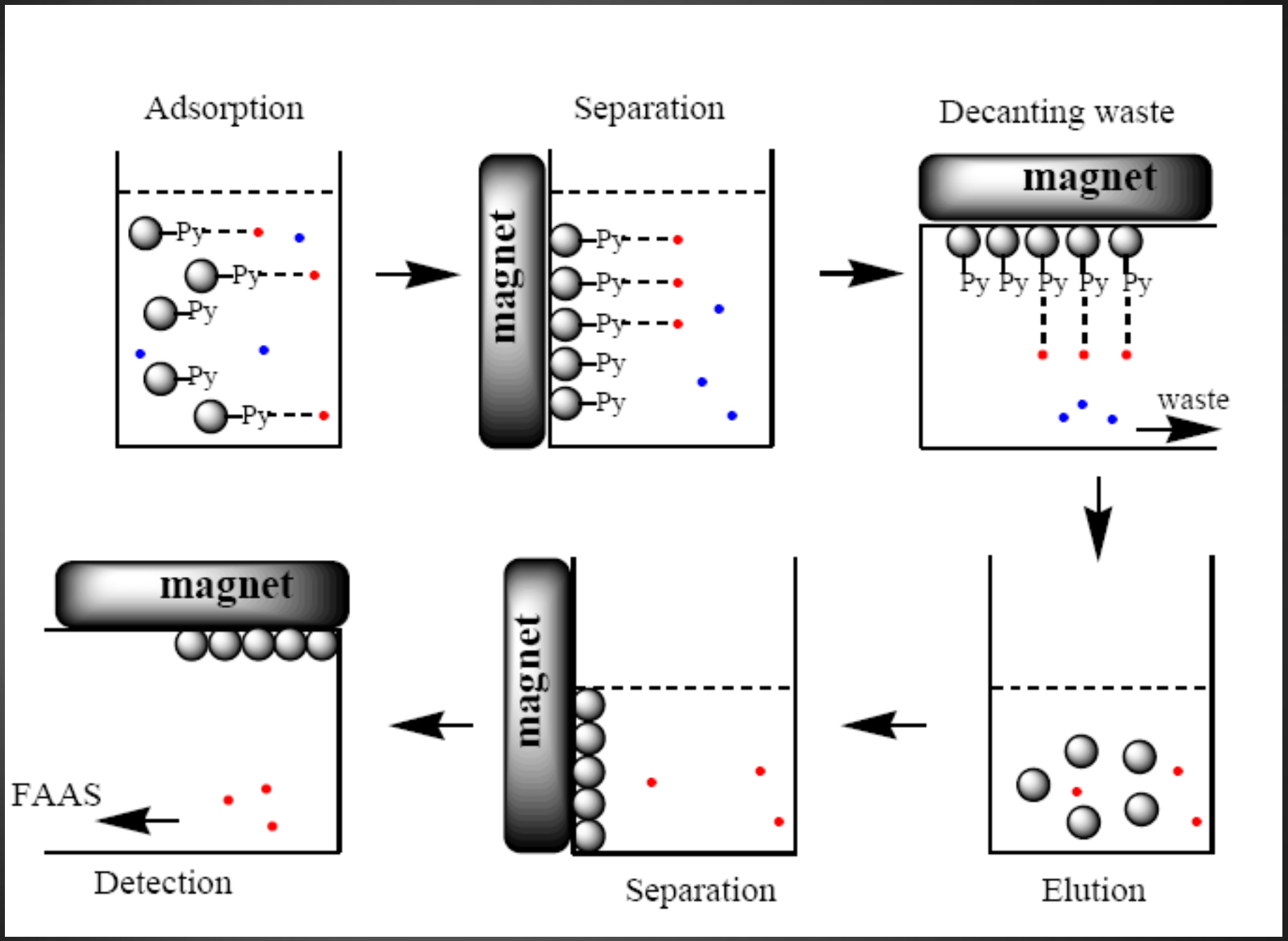


Fig. 4 A diagram of the magnetic separation of Fe_3O_4/RGO from aqueous solution "Reprinted from ACS Nano, 4, 2010, 3979–3986, Water dispersible magnetite-reduced graphene oxide composites for arsenic removal, Chandra, V., Park, J., Chun, Y., Lee, J.W., Hwang, I.C., Kim, K.S., Copyright (2010), with permission from American Chemical Society"


Adsorption
Py
Py
Py
Py
Py
Separation
magnet
Py
Py
Py
Py
Py
Decanting waste
magnet
Py Py Py Py Py
waste
Elution
Separation
magnet
magnet
FAAS
Detection

Grafen Temelli Manyetik Nanokompozitler

Talanta 146 (2016) 130–137

Contents lists available at ScienceDirect

Talanta

journal homepage: www.elsevier.com/locate/talanta

Preparation and characterization of magnetic allylamine modified graphene oxide-poly(vinyl acetate-co-divinylbenzene) nanocomposite for vortex assisted magnetic solid phase extraction of some metal ions

Mansoor Khan [a,b], Erkan Yilmaz [a], Basak Sevinc [c], Ertugrul Sahmetlioglu [c], Jasmin Shah [b], Muhammad Rasul Jan [b], Mustafa Soylak [a,*]

[a] Erciyes University, Faculty of Sciences, Department of Chemistry, 38039 Kayseri, Turkey
[b] Institute of Chemical Sciences, University of Peshawar, Peshawar, Pakistan
[c] Niğde University, Faculty of Sciences-Arts, Department of Chemistry, 51240 Niğde, Turkey

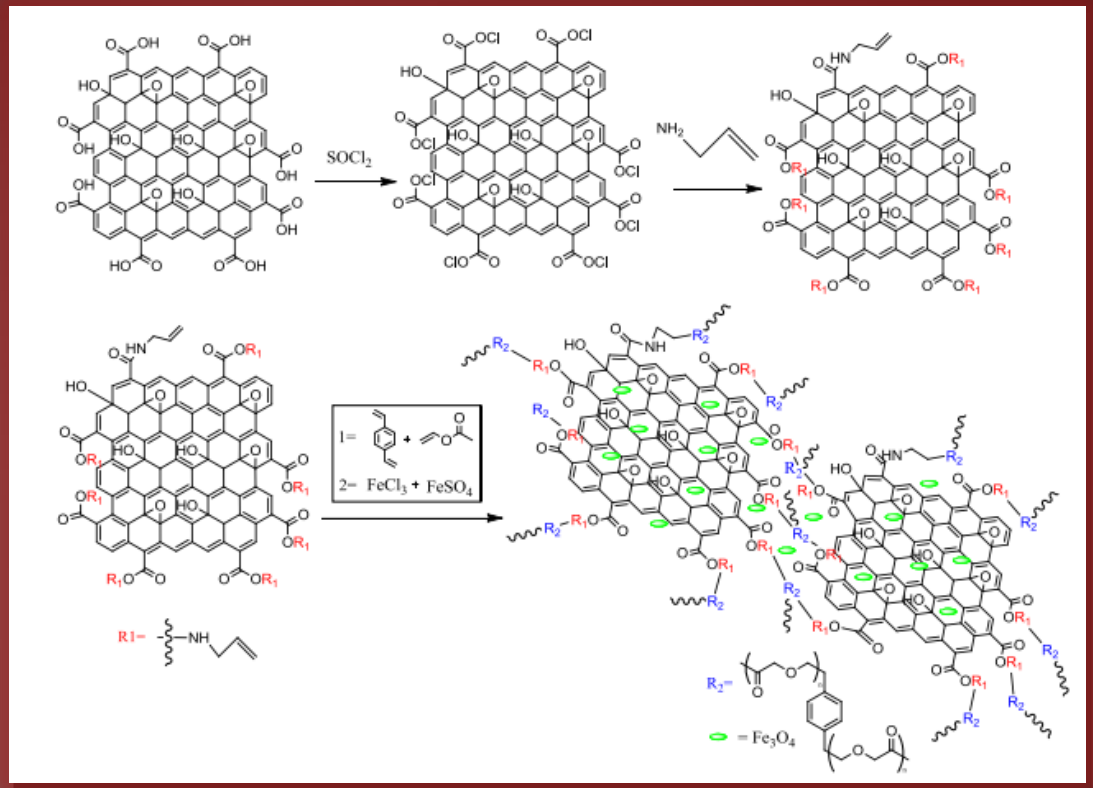
ARTICLE INFO

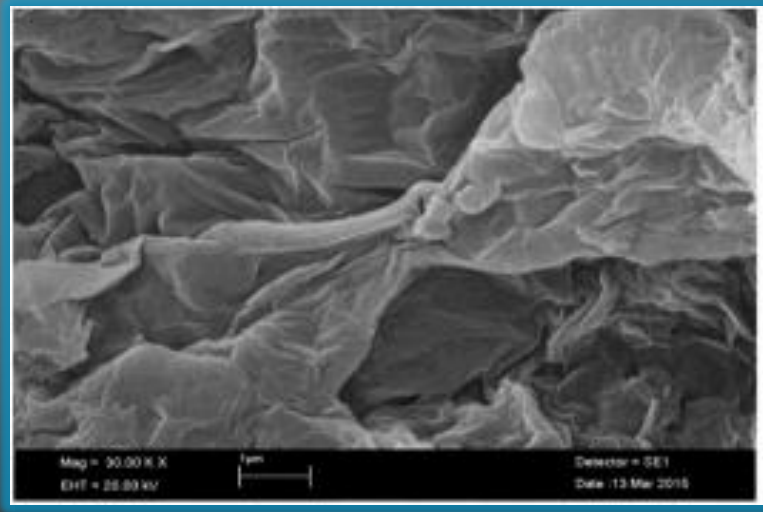
Article history:
Received 17 June 2015
Received in revised form
12 August 2015
Accepted 15 August 2015
Available online 18 August 2015

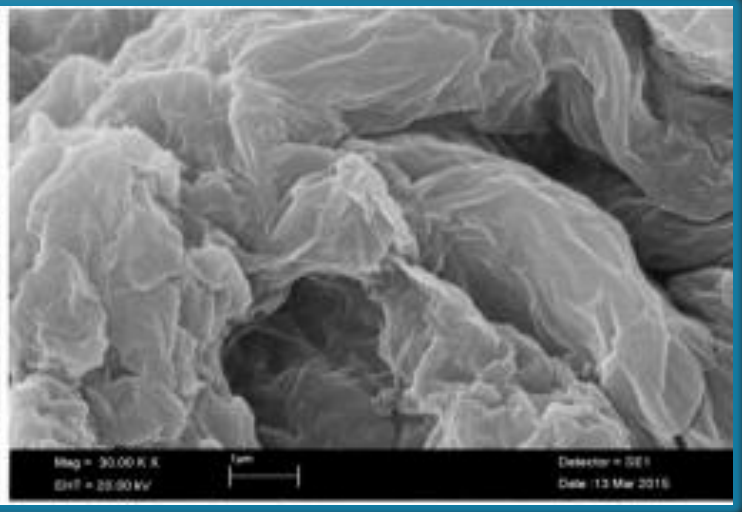
Keywords:
Magnetic solid phase extraction
Preconcentration

ABSTRACT

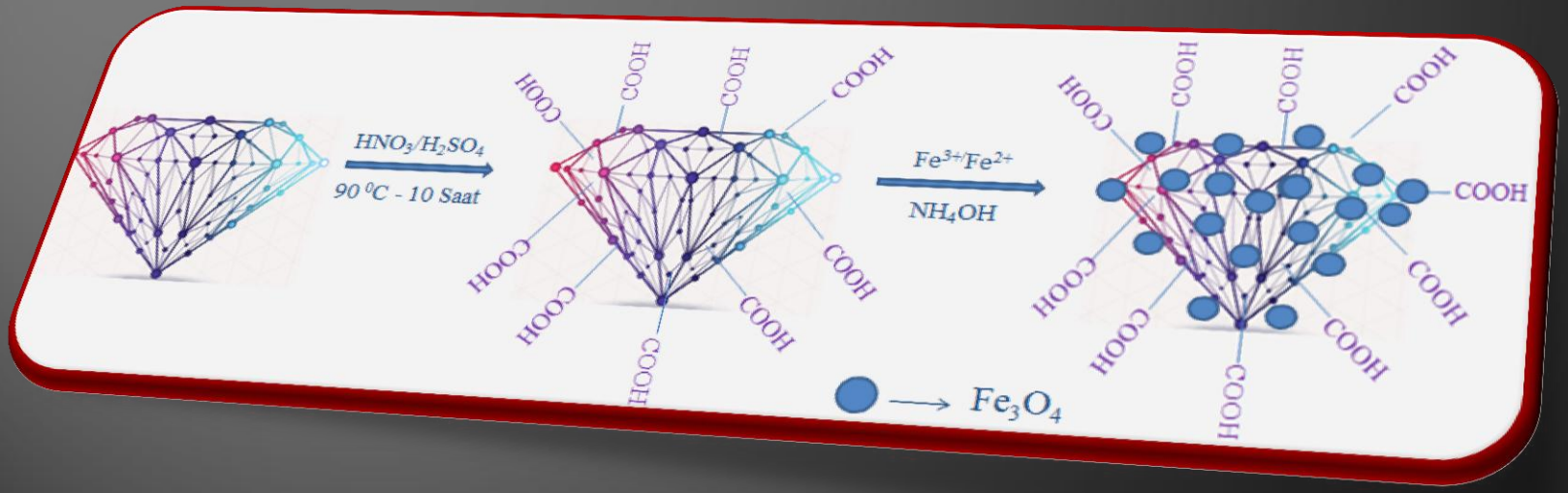
Magnetic allylamine modified graphene oxide-poly(vinyl acetate-co-divinylbenzene) (MGO-DVB-VA) was synthesized and used for magnetic solid phase extraction of Pb(II), Cd(II), Cu(II), Ni(II) and Co(II) prior to their determination by flame atomic absorption spectroscopy. The adsorbent surface functional group was characterized by using FT-IR and Raman spectroscopy. XRD pattern was used to determine the layers of GO. Surface morphology and elemental composition of the adsorbent were evaluated by using SEM and EDX analysis. Various parameters, effecting adsorption efficiency like initial solution pH, adsorbent dose, type and volume of eluent, volume of sample and diverse ions effects were optimized. The preconcentration factor (PF) is 40 for all the metals and the limits of detection for Pb, Cd, Cu, Ni and Co are in the range of 0.27–2.39 μg L^{-1} and relative standard deviation below 7.1%. The method was vali-


SOCl2
NH2
1=
2= FeCl3 + FeSO4
R1=
R2=
= Fe3O4





Çeşitli örneklerde bulunan Ziram pestisitinin zenginleştirilmesinde adsorban olarak manyetik Nanoelmasın kullanılması



Talanta 158 (2016) 152–158

Contents lists available at ScienceDirect

Talanta

journal homepage: www.elsevier.com/locate/talanta

Preparation and characterization of magnetic carboxylated nanodiamonds for vortex-assisted magnetic solid-phase extraction of ziram in food and water samples

Erkan Yılmaz, Mustafa Soylak*

Erciyes University, Faculty of Sciences, Department of Chemistry, 38039 Kayseri, Turkey

ARTICLE INFO

Article history:
Received 23 March 2016
Received in revised form
8 May 2016
Accepted 13 May 2016
Available online 14 May 2016

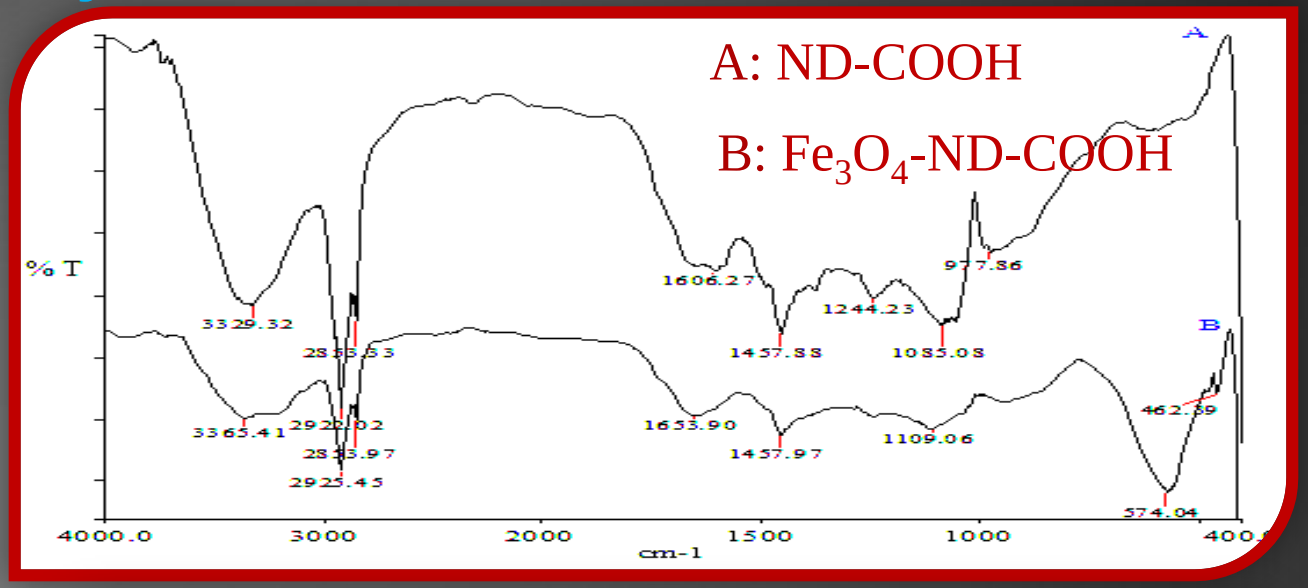
Keywords:
Dithiocarbamate pesticides
Magnetic carboxylated nanodiamonds
Magnetic solid phase extraction
Zinc
Ziram

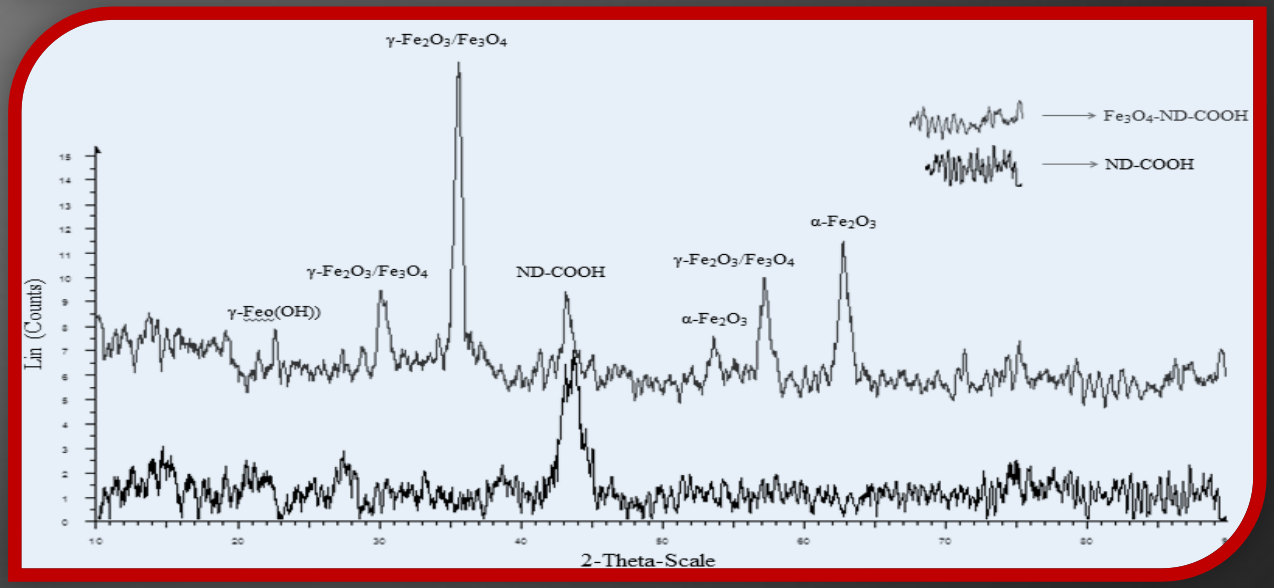
ABSTRACT

A simple and rapid vortex-assisted magnetic solid phase extraction (VA-MSPE) method for the separation and preconcentration of ziram (zinc dimethyldithiocarbamate), subsequent detection of the zinc in complex structure of ziram by flame atomic absorption spectrometry (AAS) has been developed. The ziram content was calculated by using stoichiometric relationship between the zinc and ziram. Magnetic carboxylated nanodiamonds (MCNDs) as solid-phase extraction adsorbent was prepared and characterized by Fourier transform infrared (FT-IR) spectra, X-ray diffraction (XRD) spectrometry and scanning electron microscopy (SEM). These magnetic carboxylated nanodiamonds carrying the ziram could be easily separated from the aqueous solution by applying an external magnetic field; no filtration or centrifugation was necessary. Some important factors influencing the extraction efficiency of ziram such as pH of sample solution, amount of adsorbent, type and volume of eluent, extraction and desorption time and sample volume were studied and optimized. The total extraction and detection time was lower than 10 min The preconcentration factor (PF), the precision (RSD, $n=7$), the limit of detection (LOD) and limit of quantification (LOQ) were 160, 7.0%, 5.3 $\mu g\ L^{-1}$ and 17.5 $\mu g\ L^{-1}$, respectively. The interference of various ions has been examined and the method has been applied for the determination of ziram in various waters, foodstuffs samples and synthetic mixtures.

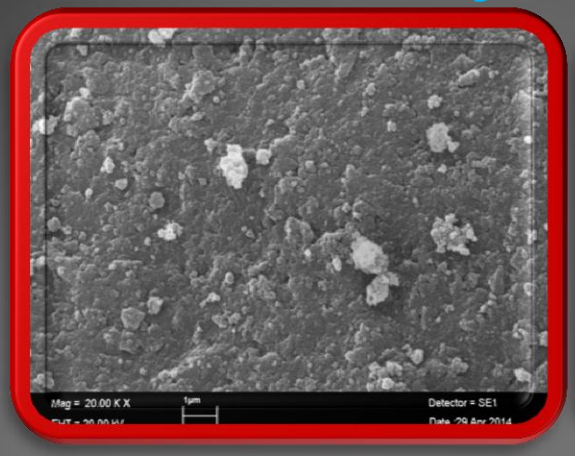
© 2016 Elsevier B.V. All rights reserved.

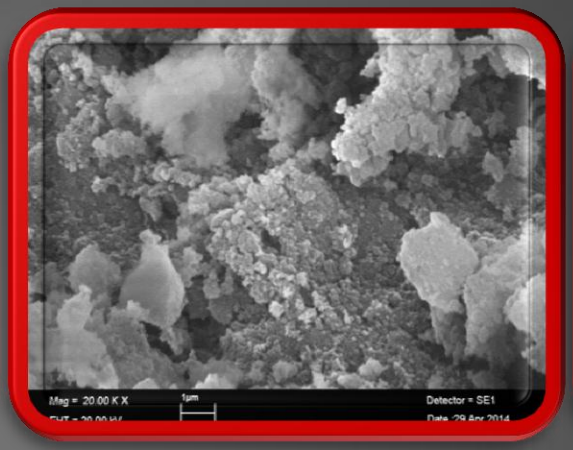
Nanoelmas ve Manyetik Nanoelmas Materyallerine Ait FT-IR ve XRD Görüntüleri

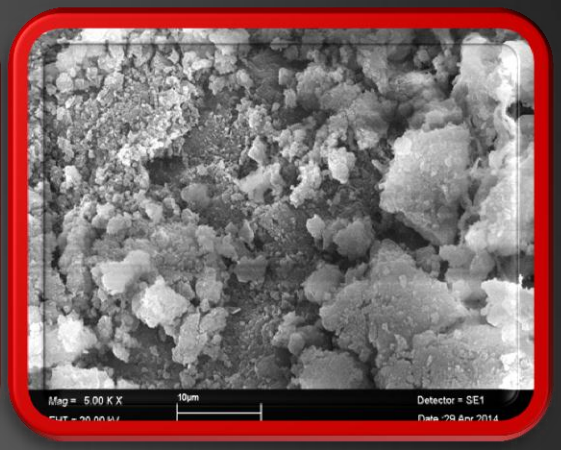


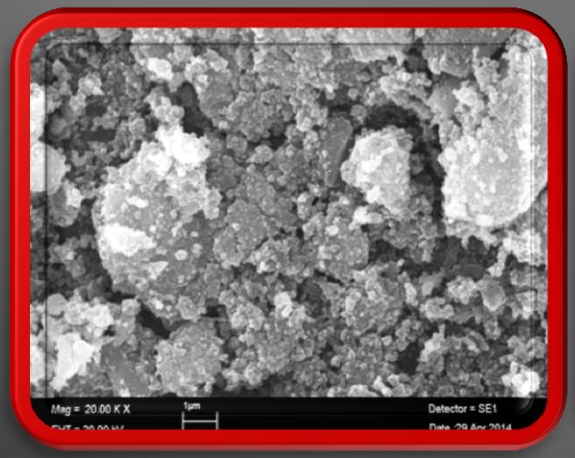


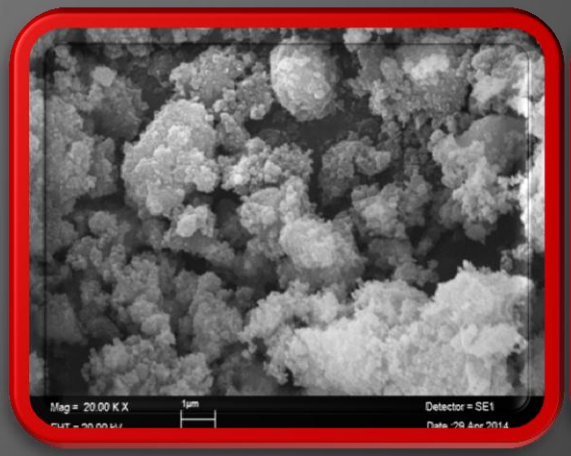
Nanoelmas ve Manyetik Nanoelmas Materyallerine Ait SEM Görüntüleri

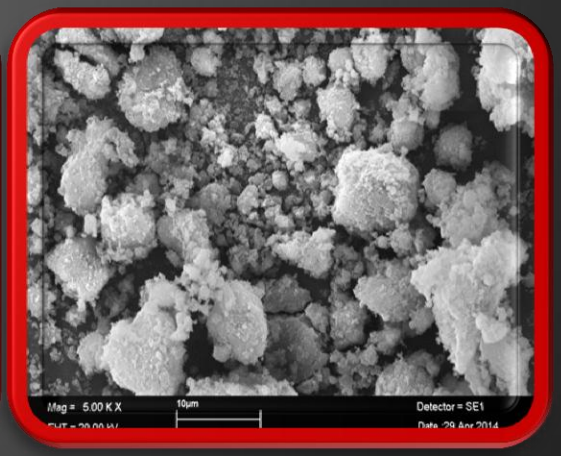










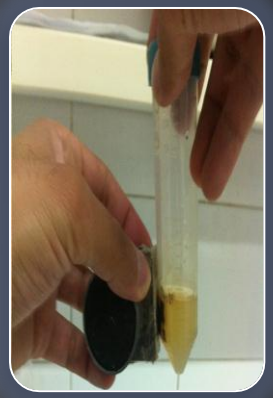


A-Nanodimond, B: Manyetik Nanodiamond

Yöntem

1- MND ilavesi ve vorteks →

2- Mıknatıs ile ayırma →



↓ 3- Su fazının ayrılması

← 4- Elüent ilavesi ve vorteks

← 5- Elüent' in alınması ve AAS ile analiz

Journal of Chromatography B 1084 (2018) 113–121

Contents lists available at ScienceDirect

Journal of Chromatography B

journal homepage: www.elsevier.com/locate/jchromb

A new magnetic nanodiamond/graphene oxide hybrid (Fe_3O_4@ND@GO) material for pre-concentration and sensitive determination of sildenafil in alleged herbal aphrodisiacs by HPLC-DAD system

Erkan Yilmaz[a,d], Halil İbrahim Ulusoy[b,*], Özge Demir[b], Mustafa Soylak[c]

[a] Erciyes University, Faculty of Pharmacy, Department of Analytical Chemistry, Kayseri, Turkey
[b] Cumhuriyet University, Faculty of Pharmacy, Department of Analytical Chemistry, Sivas, Turkey
[c] Erciyes University, Faculty of Sciences, Department of Chemistry, Kayseri, Turkey
[d] Nanotechnology Research Center (ERNAM), Erciyes University, 38039, Kayseri, Turkey

ARTICLE INFO

Keywords:
Sildenafil citrate
Magnetic hybrid material
Magnetic solid phase extraction
Graphene oxide
Nanodiamond
High performance liquid chromatography
Herbal products

ABSTRACT

A sensitive analytical methodology was investigated to concentrate and determine of sildenafil citrate (SLC) present at trace level in herbal supplementary products. The proposed method is based on simple and sensitive pre-concentration of SLC by using magnetic solid phase extraction with new developed magnetic nanodiamond/graphene oxide hybrid (Fe_3O_4@ND@GO) material as a sorbent. Experimental variables affecting the extraction efficiency of SLC like; pH, sample volume, eluent type and volume, extraction time and amount of adsorbent were studied and optimized in detail. Determination of sildenafil citrate after magnetic solid phase extraction (MSPE) was carried out by HPLC-DAD system. The morphology, composition, and properties of the synthesized hybrid material was characterized by Fourier transform infrared spectrometry (FT-IR), Raman spectrometry (Raman), X-ray diffraction spectrometry (XRD), scanning electron microscopy (SEM), mapping photographs, zeta potential analyzer, and BET surface area analysis. Under optimized conditions, linear range was ranged from 5.00 to 250.00 ng mL^{-1} with R^2 of 0.9952. The limit of detection (LOD) was 1.49 ng mL^{-1} and the recoveries at two spiked levels were ranged from 94.0 to 104.1% with the relative standard deviation (RSD) < 7.1% (n = 5). The enhancement factor (EF) was 86.9. The results show that the combination MSPE with HPLC-DAD is a suitable and sensitive method for the determination of SLC in real samples.

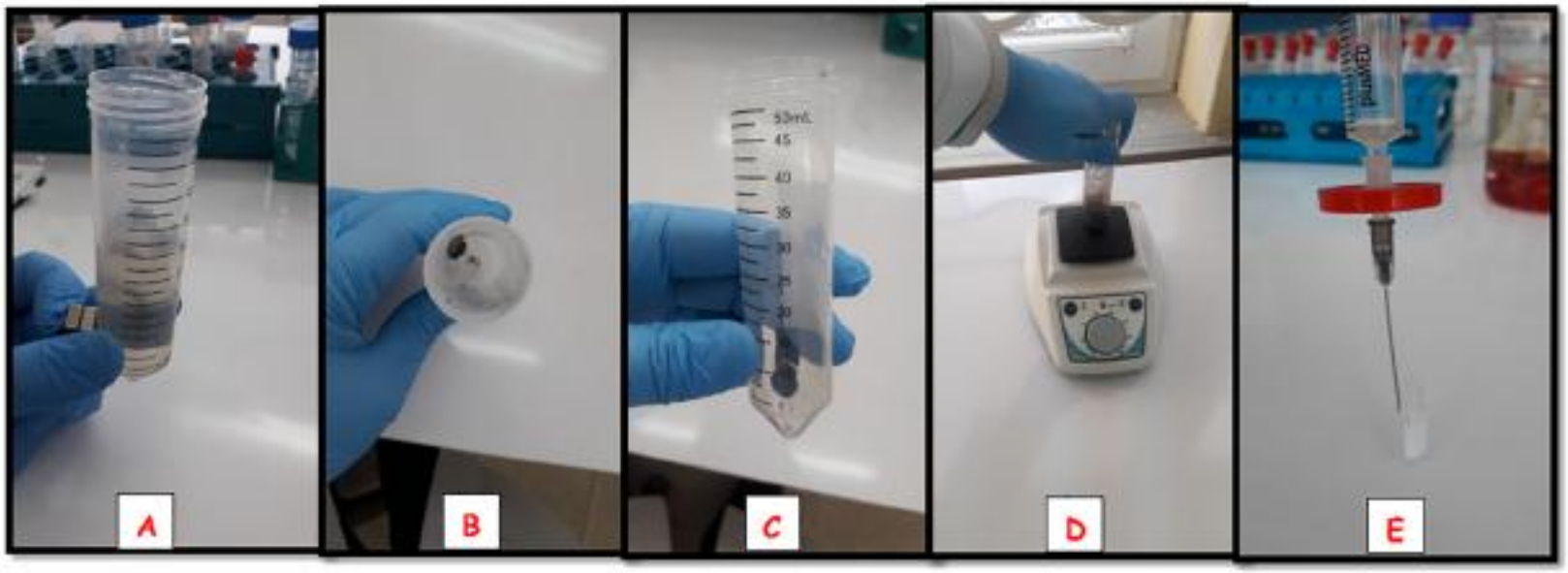


Fig. 1. The main steps of proposed magnetic solid phase extraction.

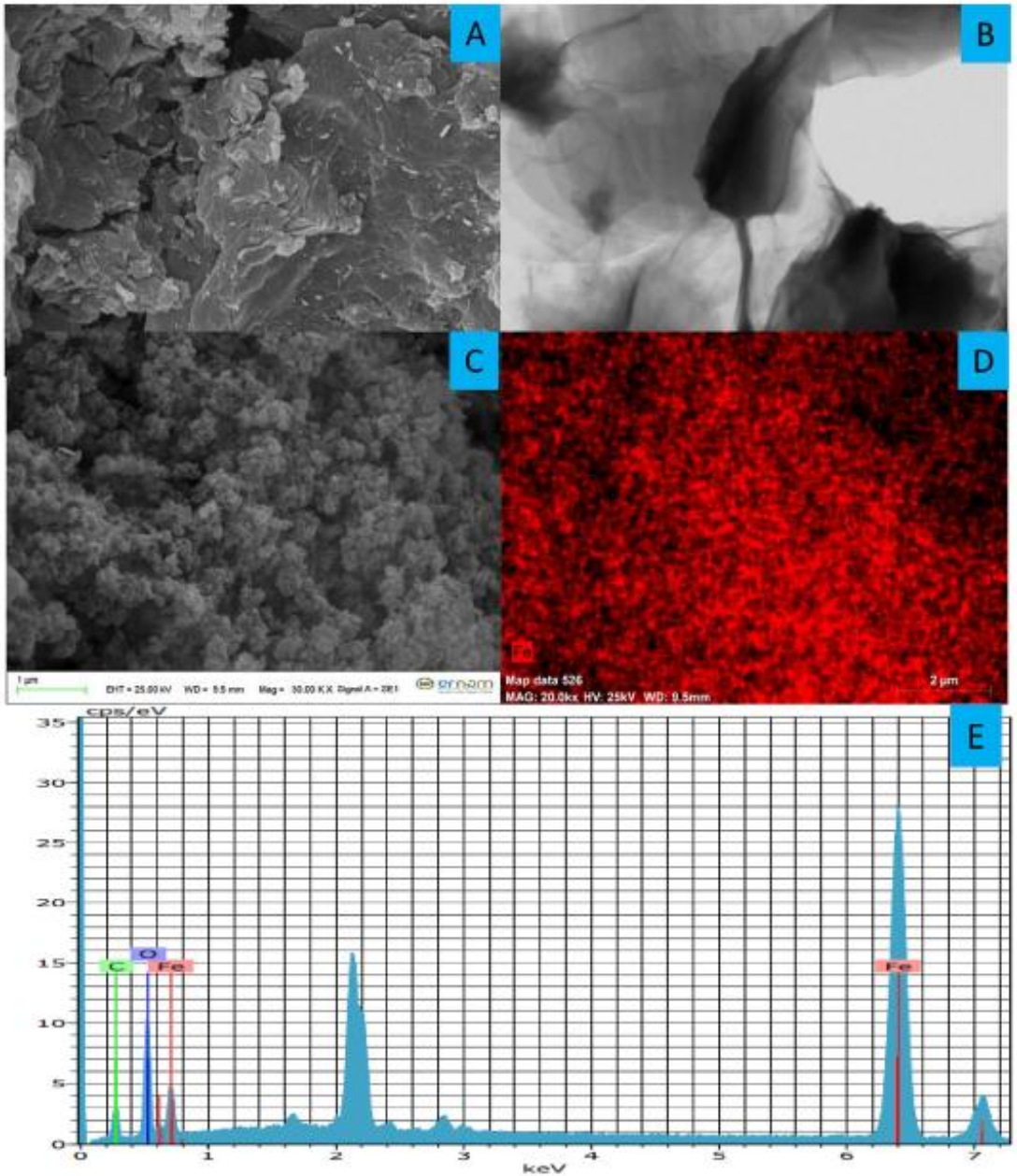


Fig. 6. SEM images of GO (A, B), SEM and SEM-Mapping images and SEM-EDX analysis of magnetic ND@GO hybrid materials (C–E).

Talanta 174 (2017) 645–651

Contents lists available at ScienceDirect

Talanta

journal homepage: www.elsevier.com/locate/talanta

One step hydrothermal synthesis and characterization of moss like MWCNT-Bi_2S_3 nanomaterial for solid phase extraction of copper

Zainab Manzoor Memon[a,b], Erkan Yilmaz[a], Mustafa Soylak[a,*]

[a] Erciyes University, Fen Fakultesi Kimya Bolumu, 38039 Kayseri, Turkey
[b] Institute of Biochemistry, University of Sindh, Jamshoro, Pakistan

ARTICLE INFO

Keywords:
Moss like MWCNT-Bi_2S_3 nanomaterial
Solid phase extraction
Copper
Tobacco
Food
Flame atomic absorption spectrometer

ABSTRACT

The present work was designed with the aim to one step simple hydrothermal synthesis of moss like MWCNT-Bi_2S_3 nanomaterial as solid phase extraction sorbent for separation, preconcentration and determination of copper in tobacco and food samples. Cu(II) ions was strongly retained on the MWCNT-Bi_2S_3 nanomaterial at the pH 7.0 and was successfully desorbed by using 1.5 mL of 4 M HNO_3. The copper concentration in eluent was determined by flame atomic absorption spectrometer. The certified reference material (NC SZC 73033 Scallion) was analyzed for the verification and accuracy of the proposed method. This work was interpreted statistically and found the analytical performance of the proposed method which consist of preconcentration factor (20), limit of quantification (13.1 μg L^{-1}) and relative standard deviation (2.2%), respectively. It was concluded that this method was applied for the detection of copper from different types of tobacco and food samples successfully.

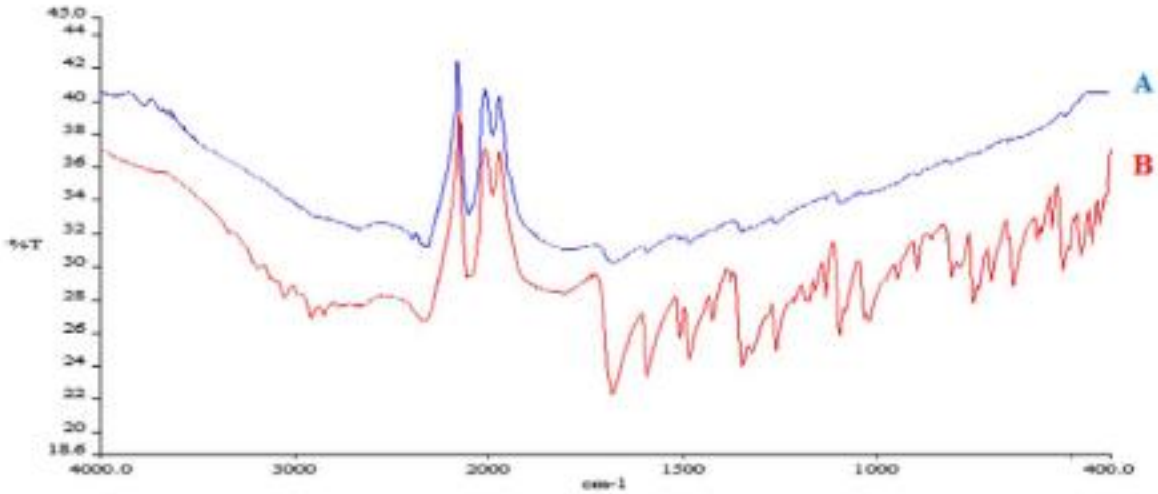


Fig. 1. FT-IR spectra of the pristine MWCNT (A) and moss like MWCNT-Bi_2S_3 nanomaterial (B).

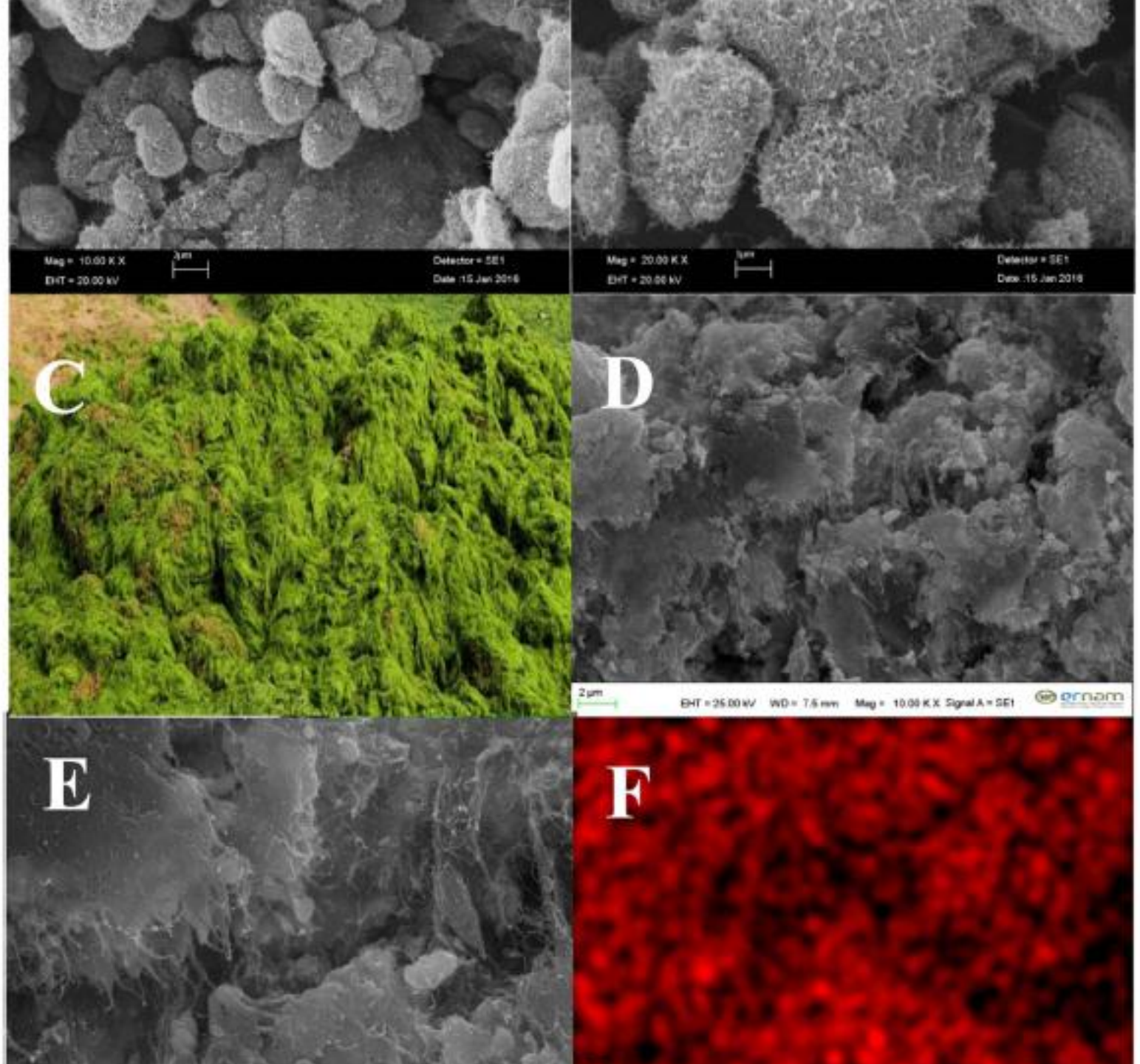

Mag = 10.00 K X
EHT = 20.00 kV
Detector = SE1
Date :15 Jan 2016
Mag = 20.00 K X
EHT = 20.00 kV
Detector = SE1
Date :15 Jan 2016
C
D
2 µm
EHT = 25.00 kV
WD = 7.5 mm
Mag = 10.00 K X
Signal A = SE1
E
F

Table 5
Application of proposed method for the evaluation of Cu(II) from tobacco and food samples using moss like MWCNT-Bi_2S_3 nanomaterial. Conditions: pH 7.0, amount of sorbent: 25 mg, eluent: 1.5 mL of 4 M HNO_3, vortex time: 2 min (N = 3).

Sample	Concentration, mg kg^{-1}
Tobacco	7.0 ± 0.5[a]
Papaver	3.6 ± 0.3
Macaroni	5.2 ± 0.2
Bread	6.8 ± 0.0
Black Paper	18.0 ± 2.5
Thyme	8.5 ± 0.7

[a] Mean ± standard deviation.

Journal of Molecular Liquids 234 (2017) 260–267

Contents lists available at ScienceDirect

Journal of Molecular Liquids

journal homepage: www.elsevier.com/locate/molliq

Nanodiamond/MoS_2 nanorod composite as a novel sorbent for fast and effective vortex-assisted micro solid phase extraction of lead(II) and copper(II) for their flame atomic absorption spectrometric detection

Neda Baghban [a,b], Erkan Yilmaz [a], Mustafa Soylak [a,*]

[a] Faculty of Sciences, Department of Chemistry, Erciyes University, 38039 Kayseri, Turkey
[b] Young Researchers Club, Shahr-e-Qhods Branch, Islamic Azad University, Tehran, Iran

ARTICLE INFO

Article history:
Received 17 December 2016
Accepted 22 March 2017
Available online 23 March 2017

Keywords:
Nanodiamond/MoS_2 composite
Lead(II)
Copper(II)
Micro solid phase extraction
Water samples
Flame atomic absorption spectrometry

ABSTRACT

This study is a report on the synthesizing nanodiamond/MoS_2 nanorod composite using the hydrothermal method and its application as adsorbent in micro solid phase extraction of lead(II) and copper(II) prior their determination through flame atomic absorption spectroscopy. The nanodiamond/MoS_2 nanorod composite was characterized using Raman spectroscopy, BET surface analysis and scanning electronic microscopy (SEM). The optimal conditions including amount of used adsorbent, pH, vortex time, elution condition and volume investigated. Quantitative recoveries for both analytes were obtained at pH 3.0. The preconcentration factor is 35, and the sorption capacity of synthesized adsorbent for lead(II) and copper(II) is 19.87 and 49.33 mg g^{-1}. The relative standard deviation is 0.9 and 1.5% for lead(II) and copper(II) at a level of 200 μg L^{-1} ($n = 6$), and the detection limit is 42 and 22 μg L^{-1} for lead(II) and copper(II), respectively. The procedure accuracy was proved via analyzing the standard reference materials (SPS-WW2 Waste water Level 2 and TMDA-53.3). The presented procedure was applied for the determination of copper and lead contents of the water samples from Turkey.

© 2017 Elsevier B.V. All rights reserved.

Microchim Acta (2017) 184:3969–3976
DOI 10.1007/s00604-017-2384-z

ORIGINAL PAPER

A magnetic MoS_2-Fe_3O_4 nanocomposite as an effective adsorbent for dispersive solid-phase microextraction of lead(II) and copper(II) prior to their determination by FAAS

Neda Baghban[1,2] · Erkan Yilmaz[1] · Mustafa Soylak[1]

Abstract The authors describe the preparation of a nanocomposite (mag-MoS_2-Fe_3O_4) that was prepared from molybdenum disulfide (MoS_2) and magnetic Fe_3O_4 nanoparticles by a hydrothermal method in an inert atmosphere. The composite is shown to be a viable magnetic adsorbent for dispersive solid phase microextraction of lead(II) and copper(II) ions from water and plant samples. The nanocomposite was characterized by FT-IR, Raman spectroscopy, XRD, SEM, and BET methods. The factors affecting the extraction recovery of the analytes, including the pH value, type of dispersive solvent, sample volume, type and volume of eluent solution, and interfering ions, were optimized. Flame atomic absorption spectrometry was then used for quantitation. Figures of merit of this method include a preconcentration factor of 50 for lead(II) and 35 for Cu(II), LODs of 3.3 $\mu g \cdot L^{-1}$ for lead(II) and of 1.8 $\mu g \cdot L^{-1}$ for Cu(II), and RSDs of 4.9 and 1.5%, respectively. The method was used to preconcentrate the analytes from plant and water samples prior to their determination by

Microchimica Acta
https://doi.org/10.1007/s00604-017-2548-x

ORIGINAL PAPER

Vortex assisted solid-phase extraction of lead(II) using orthorhombic nanosized Bi_2WO_6 as a sorbent

Neda Baghban[1,2] · Erkan Yilmaz[1] · Mustafa Soylak[1]

Received: 22 July 2017 / Accepted: 9 November 2017
© Springer-Verlag GmbH Austria, part of Springer Nature 2017

Abstract
Nanosized single crystal orthorhombic Bi_2WO_6 was synthesized by a hydrothermal method and used as a sorbent for vortex assisted solid phase extraction of lead(II). The crystal and molecular structure of the sorbent was examined using XRD, Raman, SEM and SEM-EDX analysis. Various parameters affecting extraction efficiency were optimized by using multivariate design. The effect of diverse ions on the extraction also was studied. Lead was quantified by flame atomic absorption spectrometry (FAAS). The recoveries of lead(II) from spiked samples (at a typical spiking level of 200–400 ng·mL^{-1}) are >95%. Other figures of merit includes (a) a detection limit of 6 ng·mL^{-1}, (b) a preconcentration factor of 50, (c) a relative standard deviation of 1.6%, and (d) and adsorption capacity of 6.6 mg·g^{-1}. The procedure was successfully applied to accurate determination of lead in (spiked) pomegranate and water samples.

Trends in Analytical Chemistry 103 (2018) 44–55

Contents lists available at ScienceDirect

Trends in Analytical Chemistry

journal homepage: www.elsevier.com/locate/trac

Nanomaterial's based chromium speciation in environmental samples: A review

Muhammad Balal Arain [a, b], Imtiaz Ali [a], Erkan Yilmaz [c, d], Mustafa Soylak [b, *]

[a] Department of Chemistry, Abdul Wali Khan University, Mardan, 23200, KPK, Pakistan
[b] Department of Chemistry, Faculty of Sciences, Erciyes University, 38039 Kayseri, Turkey
[c] Department of Analytical Chemistry, Faculty of Pharmacy, Erciyes University, 38039 Kayseri, Turkey
[d] Nanotechnology Research Center (ERNAM), Erciyes University, 38039, Kayseri, Turkey

ARTICLE INFO

Article history:
Available online 28 March 2018

Keywords:
Chromium
Speciation
Nanomaterials
Instrumental detection
Environmental samples
Food samples
Biological samples

ABSTRACT

To investigate critical health effects, a supporting speciation analysis is often matter of concern in order to identify figure of the bioconcentration or biomagnification of elements like chromium. Chromium speciation study requires high capacity separation and high sensitivity detection because chromium naturally exists in small quantities. Scientific literature supports chromium speciation at trace levels by using different nanomaterials and methodologies. Nanoparticles adsorbent based speciation technique is a current state-of-art technique due to its exceptional surface area chemistry, maximum mechanical strength, optical, magnetism, unique electrical, catalytic and photonic properties. The present review is aimed to discuss significance of chromium speciation and specific properties of different nanoparticles as adsorbent and also explore the new possible nanomaterials for chromium speciation. All data used for chromium speciation with various kind of nano adsorbent has also been tabulated with their analytical figure of merit.

© 2018 Elsevier B.V. All rights reserved.

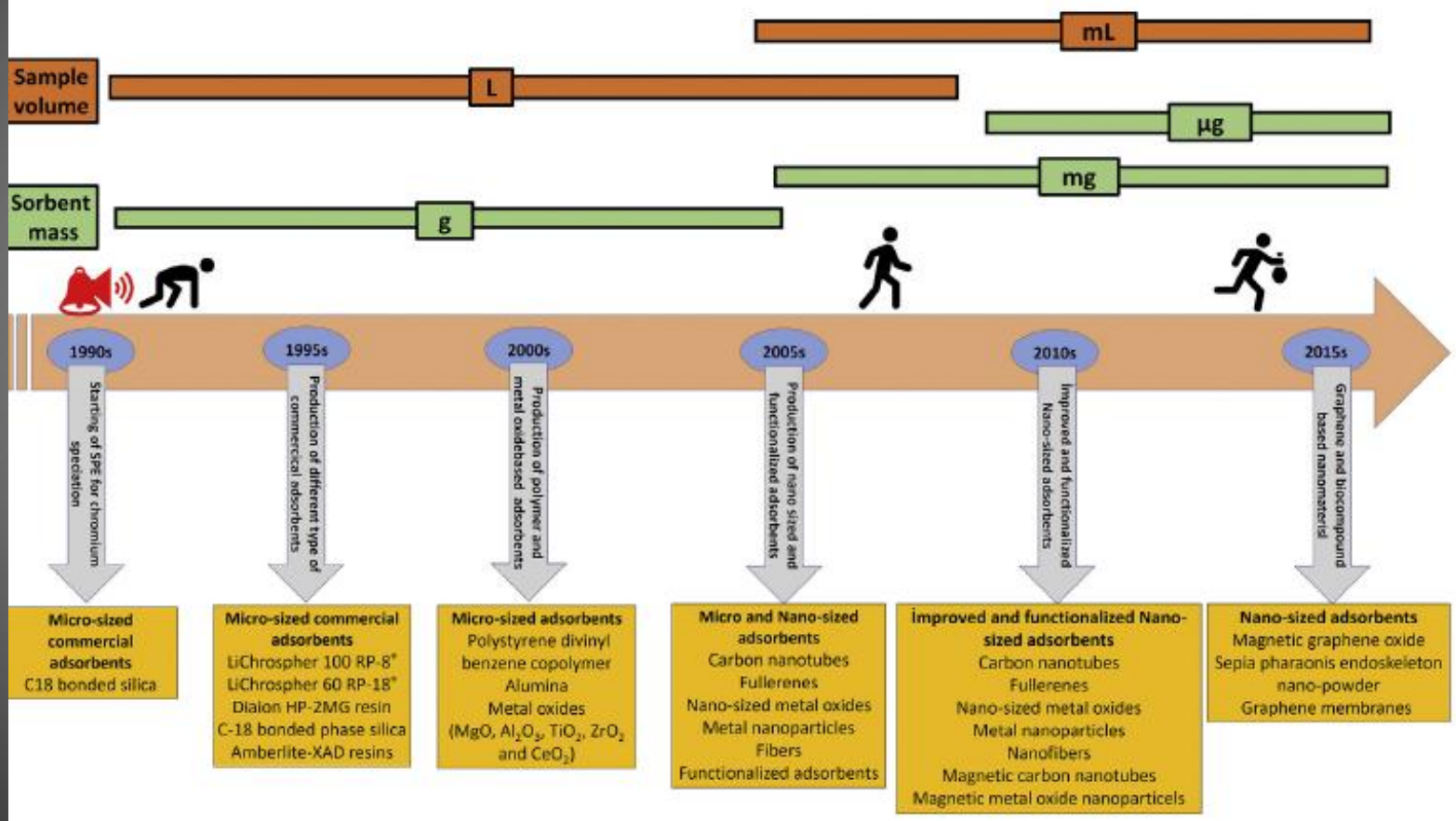
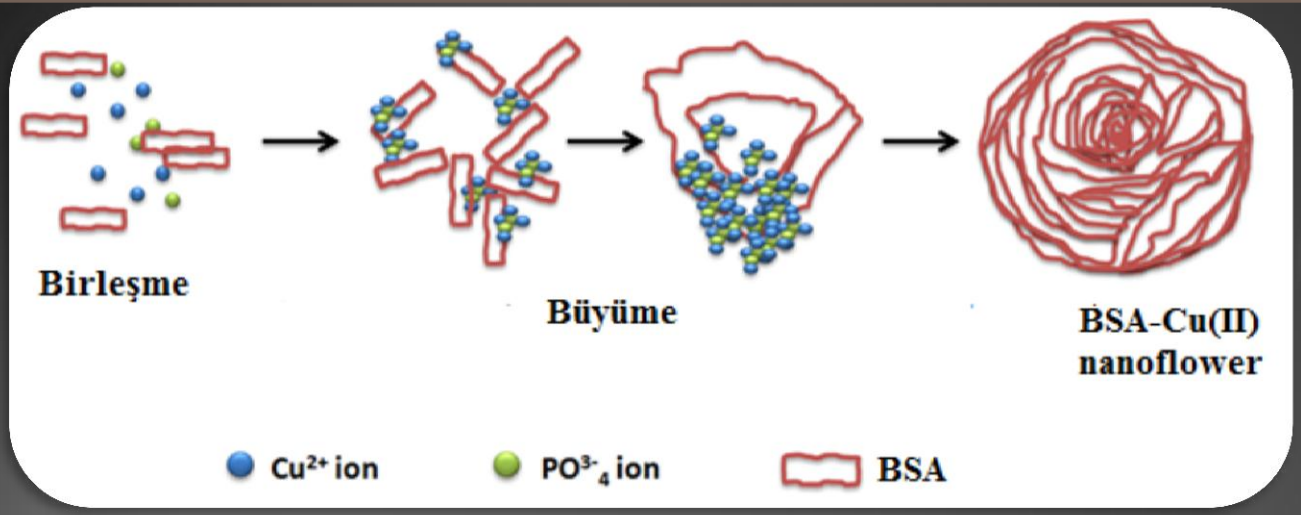
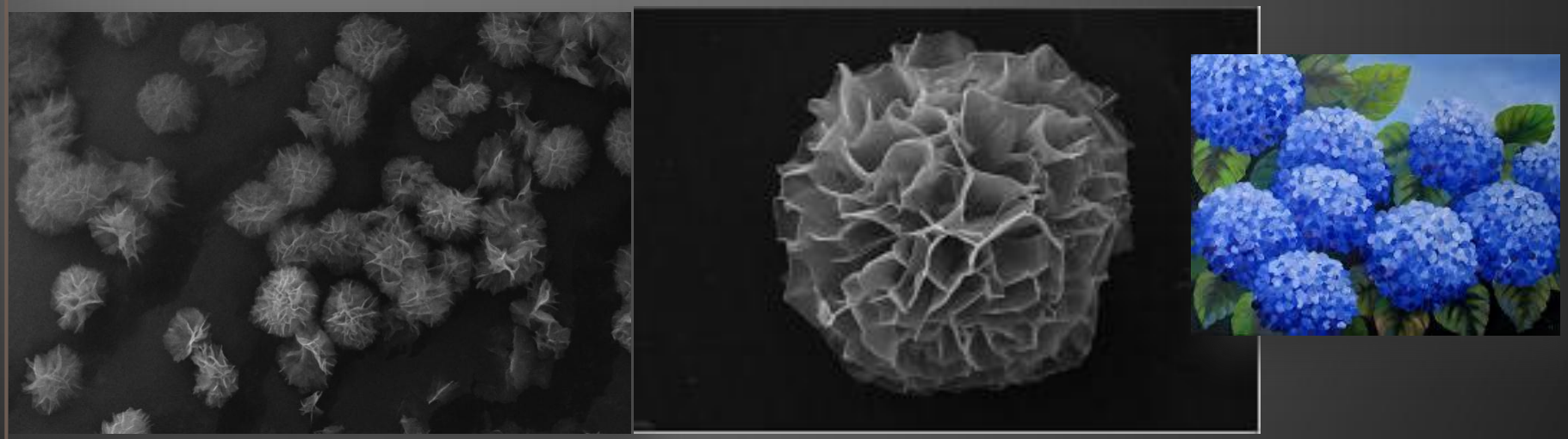


Fig. 2. The milestones in the development of adsorbent for adsorption based chromium speciation methods.

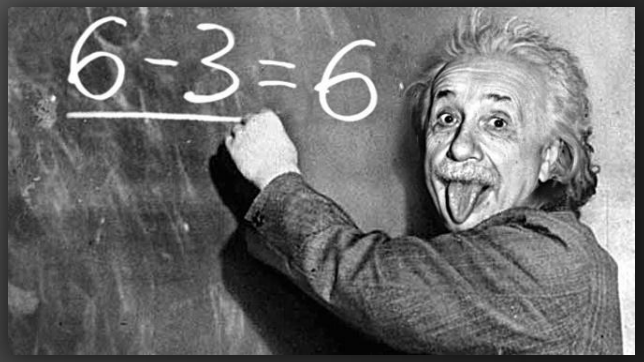




Şekil . Çiçek şekilli BSA-Cu^{2+} hibrit yapısına ait SEM görüntüleri.

TÜM BUNLAR HAYAL Mİ ?

- **“Gelecekte bilgisayarların ağırlığı 1,5 tondan daha az olabilir.” 1949, Popular Mechanics.**
- **“Peki ama, bu ne gibi bir işe yarayabilir ki?” 1968, Mikroçipler konusunda yorum yapan bir IBM mühendisi.**
- **“640K herkes için fazlasıyla yeterli.” 1981, Bill Gates.**
- ***“Hayal gücü bilgiden daha önemlidir.” Albert Einstein***



Teşekkür

- Erciyes Üniversitesi
- Tubitak
- Hacettepe Üniversitesi
- Pamukkale Üniversitesi
- Karadeniz Teknik Üniversitesi
- Gaziosmanpaşa Üniversitesi
- Nevşehir Hacı Bektaş Veli Univers
- Niğde Üniversitesi
- Gümüşhane Üniversitesi
- Çanakkale 18 Mart Üniversitesi
- Van Yüzüncü Yıl Üniversitesi
- Siirt Üniversitesi
- Cumhuriyet Üniversitesi

- King Saud University- Suudi Arabistan
- Sindh University Pakistan
- University of Peshawer -Pakistan
- Yasouj University- Iran
- Baku State University - Azarbeycan
- Universidade Federal da Bahia, Brezilya
- National Research Centre , Mısır
- University of Girona, Girona, Spain
- University of Pavol Jozef Safárik, Slovakya

Teşekkürler

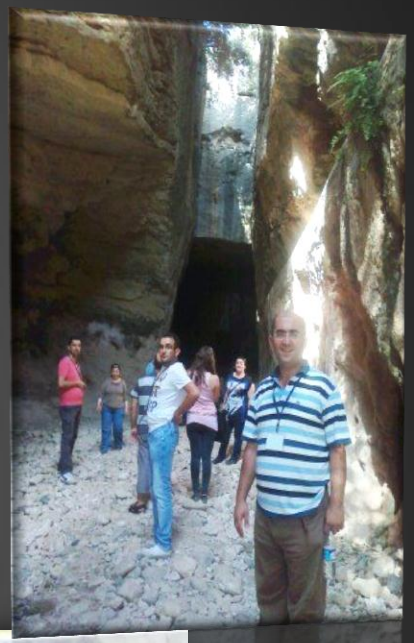
Soylak Araştırma Grubu

http://www.soylak.tr.gg

Dinlediğiniz İçin Teşekkürler…

Soylak Araştırma Grubu

www.soylak.tr.gg



Check for updates

Article

Toxicology and Industrial Health

Toxicology and Industrial Health
2018, Vol. 34(3) 169–177
© The Author(s) 2017
Reprints and permissions:
sagepub.co.uk/journalsPermissions.nav
DOI: 10.1177/0748233717744430
journals.sagepub.com/home/tih
SAGE

The reproductive and developmental toxicity of nanoparticles: A bibliometric analysis

Zengjin Wang, Tongchao Zhang, Fengyan Huang and Zhiping Wang

Abstract

Because of the advantages of nanoparticles (NPs) in a variety of industrial, biomedical, and consumer applications, they are intentionally (such as in medicine) or unintentionally (environment exposure) introduced into the human body. However, to date, the detrimental effects of NPs are still unclear, especially in reproductive and developmental toxicity. In this study, we researched 266 articles related to the reproductive and developmental toxicity of NPs from 2006 to December 2016 based on the database of the Web of Science. According to the bibliometric analysis, we found that China and the United States were the leading countries in this field and the major research trends might focus on the pathogenesis of NPs, such as oxidative stress, inflammation, and DNA damage. By this analysis, we provide new insights into the research trends and characteristics of the field.

Keywords

Nanoparticles, reproductive and developmental toxicity, bibliometric analysis, oxidative stress

Received 11 September 2017; Revised 7 October 2017; Accepted 17 October 2017

Check for updates

Review

Toxicology and Industrial Health

Toxicology and Industrial Health
1–11
© The Author(s) 2018
Reprints and permissions:
sagepub.co.uk/journalsPermissions.nav
DOI: 10.1177/0748233717747472
journals.sagepub.com/home/tih
SAGE

Toxicity of carbon nanotubes: A review

Arul Prakash Francis and Thiyagarajan Devasena

Abstract

Carbon nanotubes (CNTs) are widely used in the aerospace, automotive, and electronics industries because of their stability, enhanced metallic, and electrical properties. CNTs are also being investigated for biomedical applications such as drug delivery systems and biosensors. However, the toxic potential of CNTs was reported in various cell lines and animal models. The toxicity depends on diverse properties of the CNTs, such as length, aspect ratio, surface area, degree of aggregation, purity, concentration, and dose. In addition, CNTs and/or associated contaminants were well known for oxidative stress, inflammation, apoptosis, pulmonary inflammation, fibrosis, and granuloma in lungs. The increased production of CNTs likely enhanced the possibility of its exposure in people. Studies on the toxicity of CNTs are mainly focused on the pulmonary effects after intratracheal administration, and only a few studies are reported about the toxicity of CNTs via other routes of exposure. So, it is essential to consider the chronic toxicity of CNTs before using them for various biomedical applications. This review focuses on the potential toxicities of CNTs.

Keywords

Carbon nanotubes, aggregation, intratracheal, granuloma, inflammation

Received 21 August 2017; Revised 31 October 2017; Accepted 13 November 2017

Nanoteknolojinin bazı dezavantajları

- **Nano teknoloji** ürünü olan ve ayak kokusunu gidermek için geliştirilen gümüş nanopartiküllü çoraplar insan derisine zarar verebilir.
- Bakteriyostatik olan bakteri su arıtma tesislerinde organik madde parçalayarak yararlı bakterilerin yok olmasına neden olabilir.
- Nanoteknoloji ile üretilen ürünler havada yüzerler, bu partikülleri soluyan insanlar ve hayvanların iç organları bu yabancı partiküllerden zarar görebilir. vücudun savunma mekanizmasını zayıflatabilir.
- Nanoteknoloji ürünlerinin doğaya ne kadar zarar verdiğini araştırmak için onların yaşam döngüsündeki aktivitelerin incelenmesi gerekir.