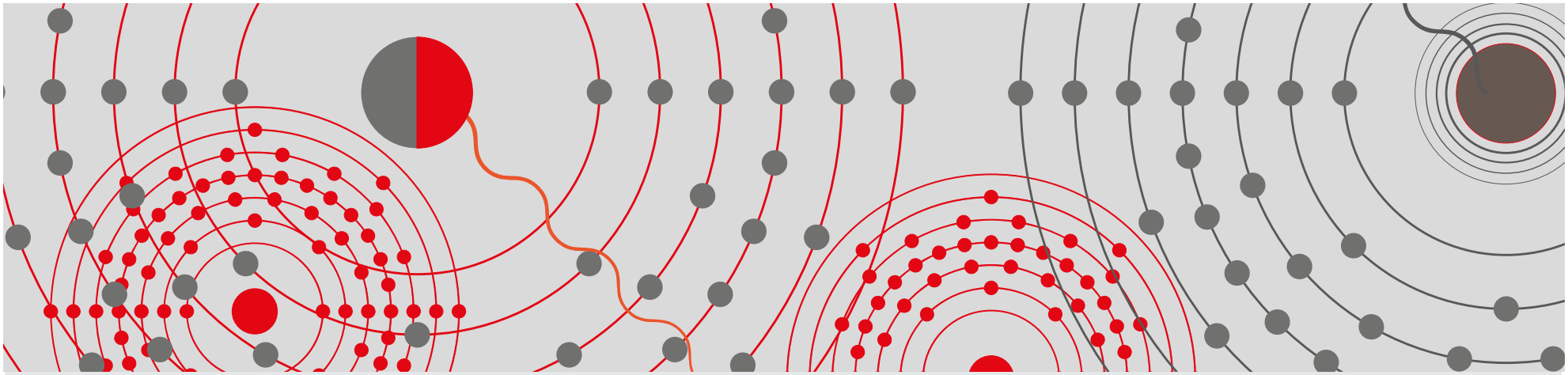
Part of SPRINGER NATURE



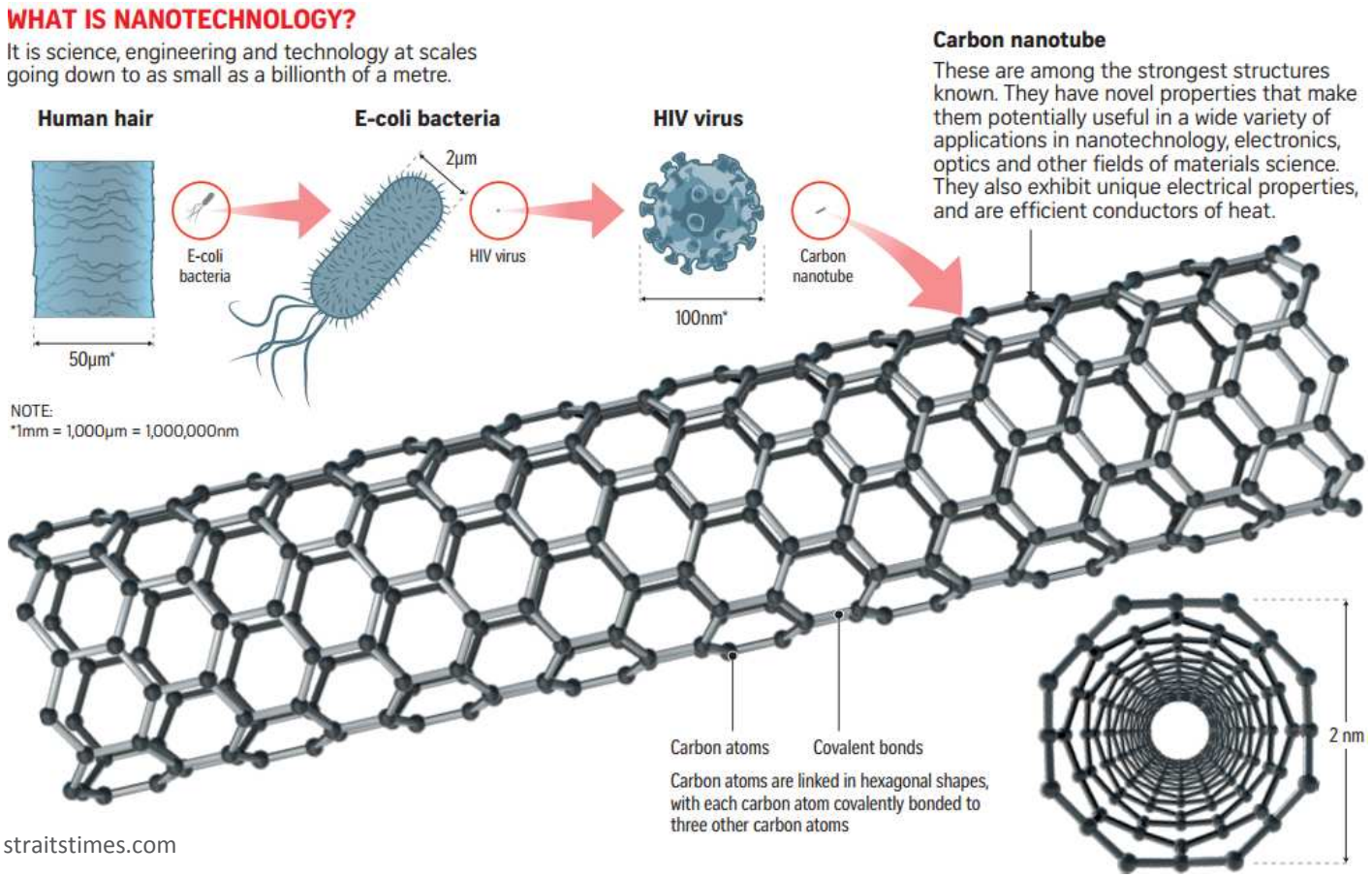
Nano a Nature Research Solution

Dr. Prathik Roy, Product Manager - NY

nature research

Nanoscience & technology – quick intro

- Nanoscience & technology is the **understanding and control of matter at the nanometer scale** where unique phenomena enable novel applications.



straitstimes.com

Nanotech for Pharma and Bio-Tech

nature research

Nanotech for Pharma and Bio-Tech

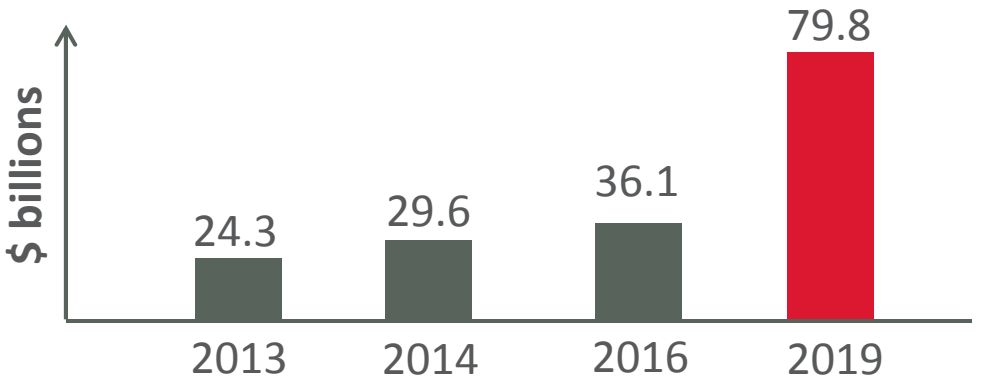
> 200 companies work on commercialization of nano-enabled products in pharma and bio [2]

43 products have been approved as nano-drugs (counted in 2014) [3]

100 nanopharmaceuticals are clinically approved and on the market (counted in 2013) [4]

E.g. $5.4 billions sales for nanomedicine in drug delivery sector. [2]

Global market for nanomaterials in pharma and biotech [1]



[1] www.bccresearch.com, 2014
[2] Wagner et al., Nature biotechnology, 24, 10, 2006
[3] Weissig V et al. (2014) Int. J. Nanomed 9: 4357-73
[4] Etheridge ML et al. (2013) Nanomedicine 9(1): 1-14

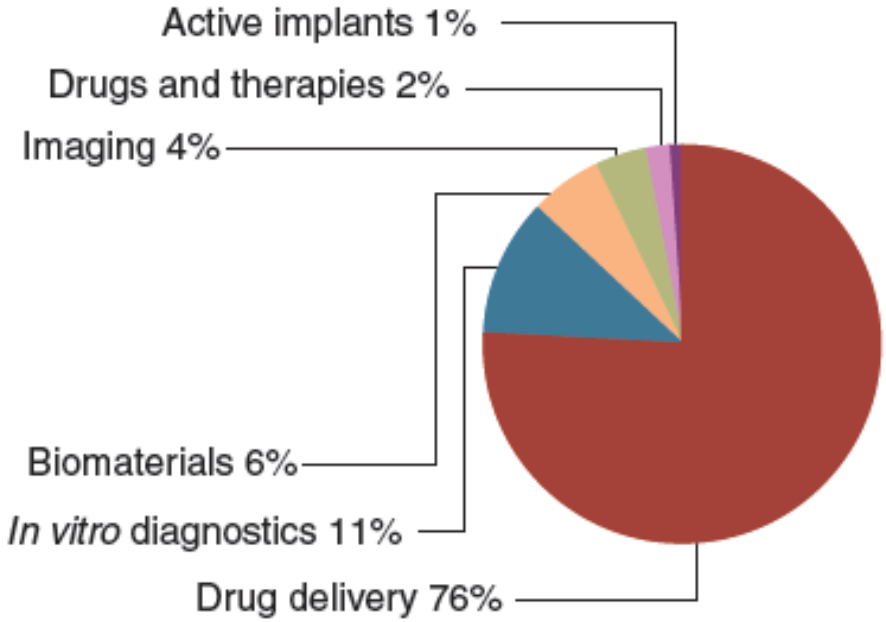
nature research

Pharma and Bio Applications of Nanotechnology

Nanotechnology can be used for monitoring, repair, construction and control of biological systems at the molecular level, using engineered nanodevices and nanomaterials.

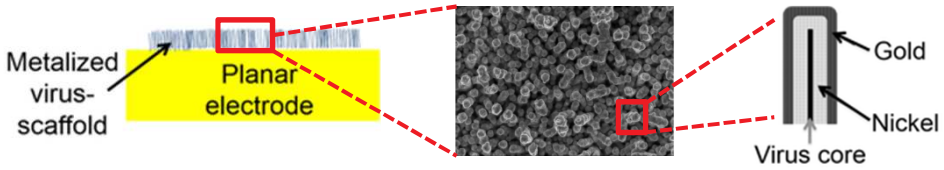
Application areas include:

- Drug delivery
- Diagnostics
- Drugs and Therapy
- Gene delivery
- Imaging
- Biomaterials
- Implants



Wagner et al., Nature biotechnology, 24, 10, 2006

Examples of Nanotechnology applications in biotech

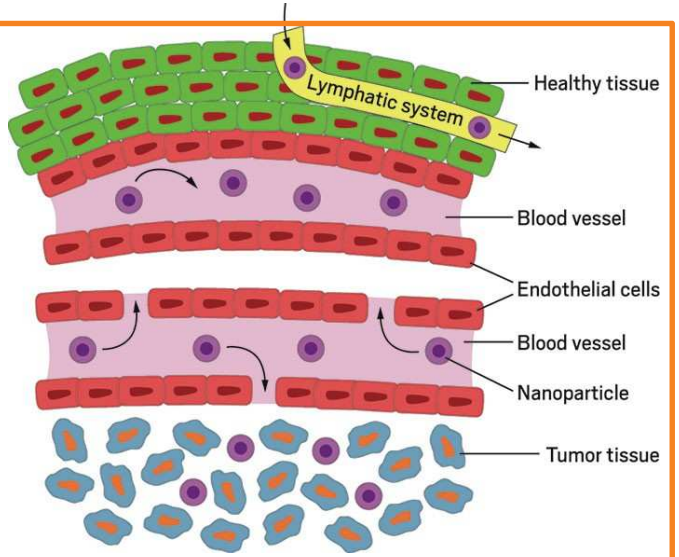


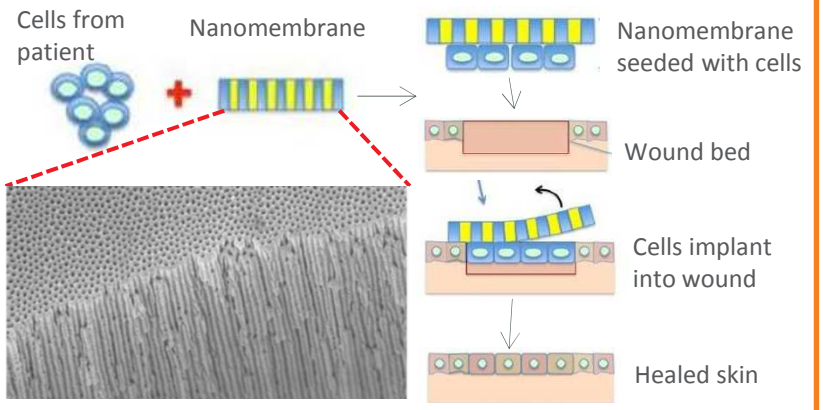
Better sensitivity of Biosensor made of metalized virus nanoelectrodes.
nanobioelectronics.weebly.com

Bionanoelectronic: Highly sensitive detection and stimulation of neuronal signal by Silicon Nanowire transistors integrated with Neuron
DOI: 10.1126/science.1128640

Effective Nanomedicine:

Enhanced permeability and retention (EPR) effect is supposed to help nanoparticles of certain size range (10 – 100 nm) accumulate in tumors.
Cen.acs.org, vol. 94, 25, 16-19, 2016

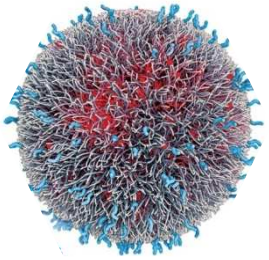


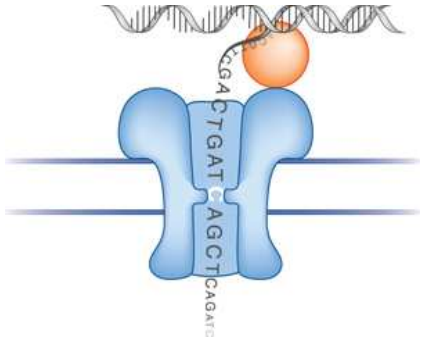


Skin replacement by Nanomembrane made of aluminium oxide.
doi:10.3390/ma4030487

Nanomedicine for Specific Targeting:

Changing the design of nanoparticles—such as their size, shape, and surface chemistry— helps efficient targeting of tumors.
Cen.acs.org, vol. 94, 25, 16-19, 2016





Nano tools for biotech:

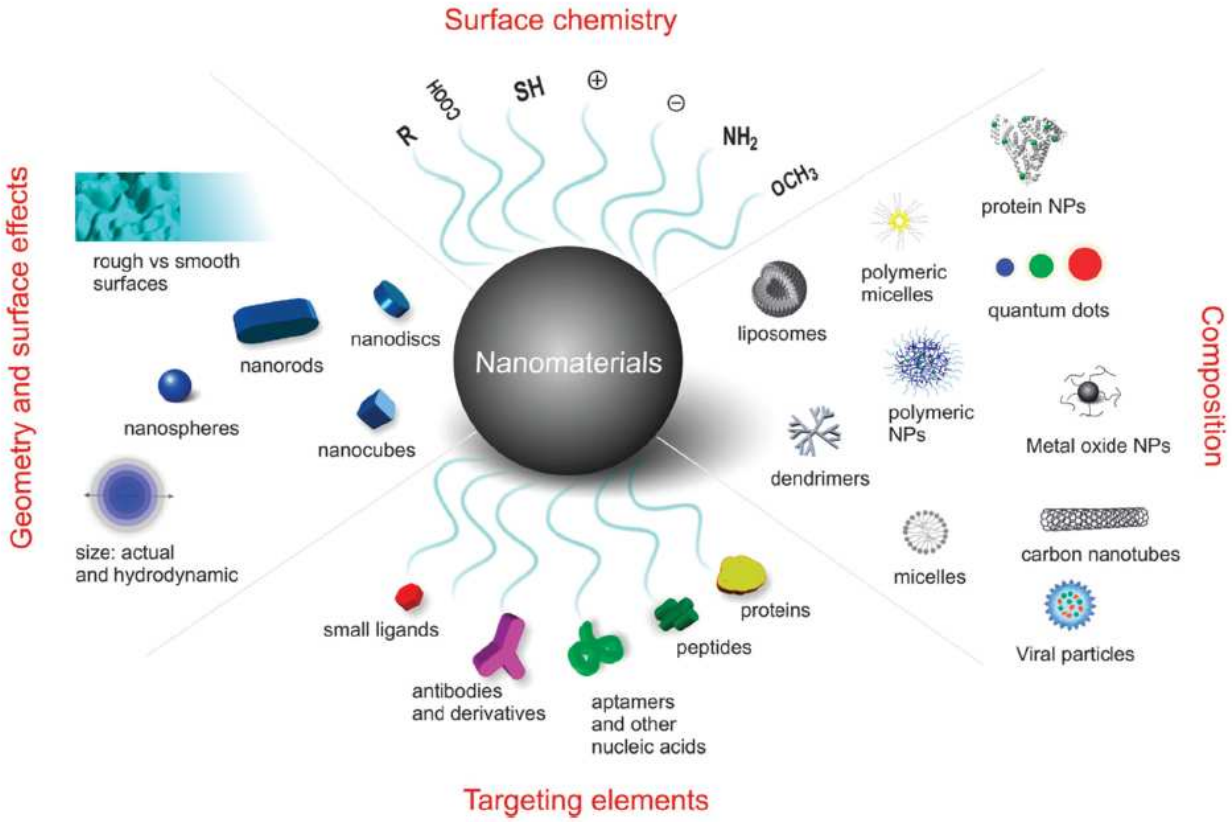
Read the DNA sequence by passing through the nanopore
doi:10.1038/nmeth.2292

nature research

Challenges ahead

Finding exact and relevant information is a key step in the product development chain.

There are many nanomaterials characteristics which affect the performance both in vivo and in vitro. [1]



[1] Kamaly et al., Chem .Soc. Rev., 2012,41, 2971-3010

Pain:Navigating the Ocean of Content

- **The Global Research[1-3] Landscape in 2015:**

8,000,000 active researchers

2,400,000 patent applications

24,000 books released

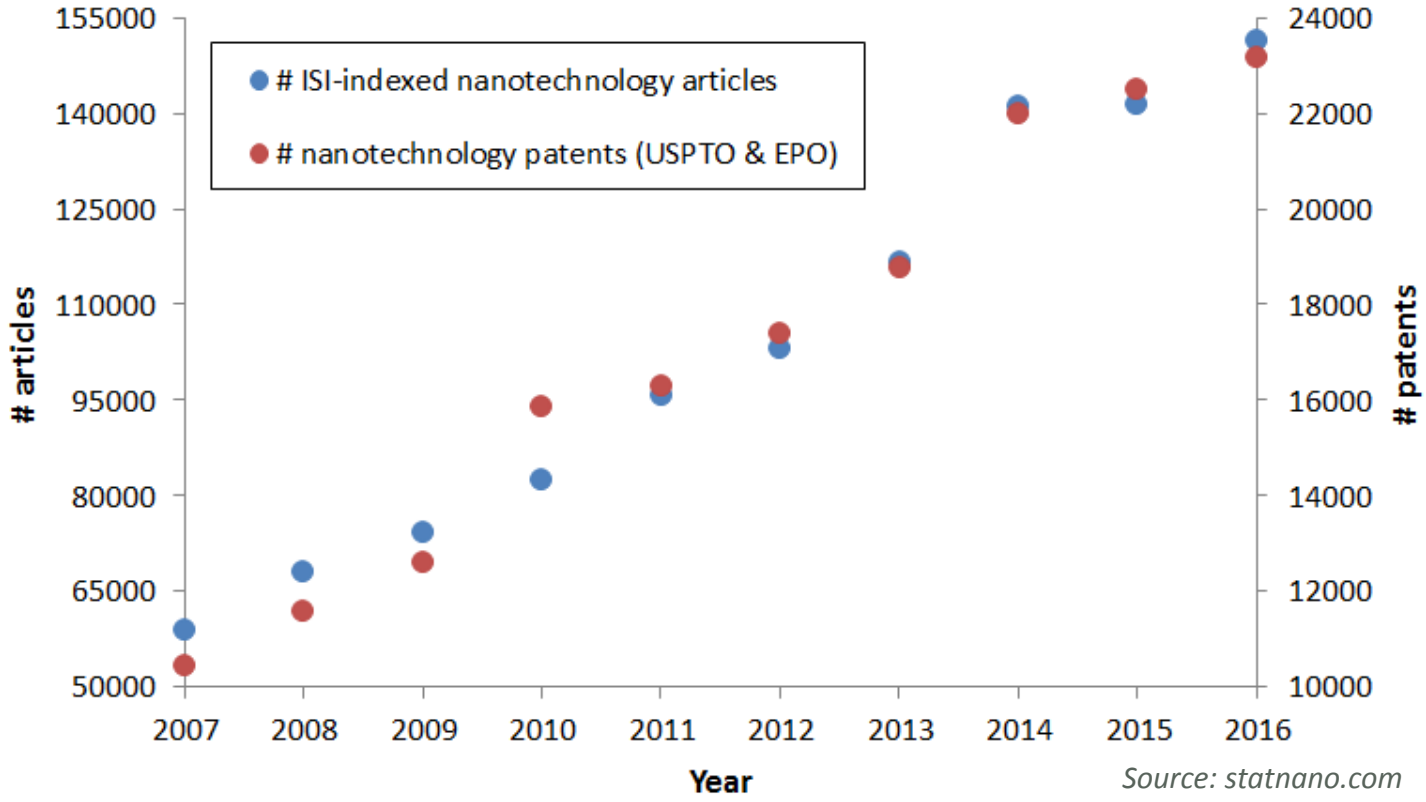
34,000 peer reviewed journals

2,500,000 journal articles published

- **The Challenge:**
  - Special tools needed are needed to quickly and accurately find scientific data across multiple sources

1) "The STM Report, 4th Edition". International Association of STM Publishers, Feb. 20, 2015.
2) "Key IP5 Statistical Indicators 2015". IP5 Offices, Mar. 2016.
3) "21st Century Science Overload", Canadian Science Publishing, Jan. 7, 2016.

Nanoscience & technology - a booming field



Source: statnano.com

- Vast amount of **information and data scattered** throughout journals and patents require classification, indexing and curation for proper management and effective communication.
- Currently **no standardized nomenclature** for nanomaterials.

Major pain points with existing resources for nanotechnology

1. Large number of irrelevant search results
2. Validating relevancy requires access to the original source
3. Scattered information for similar nanomaterials/devices
4. No single list available for nanomaterials/devices with certain properties or for specific applications
5. Tedious to reconstruct preparation methods and steps for nanomaterials/devices from text

Case study #1 – A general search

Google Scholar

nanosheets and electrical conductivity

Articles

About 79,900 results (0.12 sec)

Any time
Since 2017
Since 2016
Since 2013
Custom range...

Sort by relevance
Sort by date

include patents
include citations

Create alert

Synthesis of graphene-based nanosheets via chemical reduction of exfoliated graphite oxide
S Stankovich, DA Dikin, RD Piner, KA Kohlhaas... - carbon, 2007 - Elsevier
... Synthesis of graphene-based **nanosheets** via chemical reduction of exfoliated graphite oxide. ... By nature, GO is **electrically** insulating (see below) and thus cannot be used, without further ... Notably, it has been demonstrated that the **electrical conductivity** of GO (and presumably its ...
Cited by 8840 Related articles All 20 versions

Processable aqueous dispersions of graphene nanosheets
D Li, MB Müller, S Gilje, RB Kaner... - Nature nanotechnology, 2008 - nature.com
... work may lead to the development of a new generation of antistatic coatings that can combine **electrical conductivity** with transparency ... Synthesis of graphene-based **nanosheets** via chemical reduction of exfoliated graphite oxide. ... **Electric** field effect in atomically thin carbon films. ...
Cited by 6272 Related articles All 15 versions

Preparation and electrical properties of graphene nanosheet/Al 2 O 3 composites
Y Fan, L Wang, J Li, J Li, S Sun, F Chen, L Chen... - Carbon, 2010 - Elsevier
Fully dense graphene **nanosheet** (GNS)/Al2O3 composites with homogeneously distributed GNSs of thicknesses ranging from 2.5 to 20nm have been fabricated from ball milled expanded graphite and Al2O3 by spark plasma sintering. The percolation threshold of
Cited by 227 Related articles All 8 versions

Two-dimensional nanosheets produced by liquid exfoliation of layered materials
JN Coleman, M Lotya, A O'Neill, SD Bergin... - ..., 2011 - science.sciencemag.org
... Tae Kim. School of **Electrical** Engineering, Korea University, Seoul, South Korea. ... 1 Optical characterization of **nanosheet** dispersions. ... We performed transmission electron microscopy (TEM) analysis on our dispersions, typically observing 2D flakes consisting of thin **nanosheets**. ...
Cited by 3049 Related articles All 16 versions

Comparison of electrical properties between multi-walled carbon nanotube and graphene nanosheet/high density polyethylene composites with a segregated network ...
J Du, L Zhao, Y Zeng, L Zhang, F Li, P Liu, C Liu - Carbon, 2011 - Elsevier
Multi-walled carbon nanotube (MWCNT)/high density polyethylene (HDPE) and graphene **nanosheets** (GNS)/HDPE composites with a segregated network structure were prepared by alcohol-assisted dispersion and hot-pressing. Instead of uniform dispersion in polymer
Cited by 194 Related articles All 15 versions

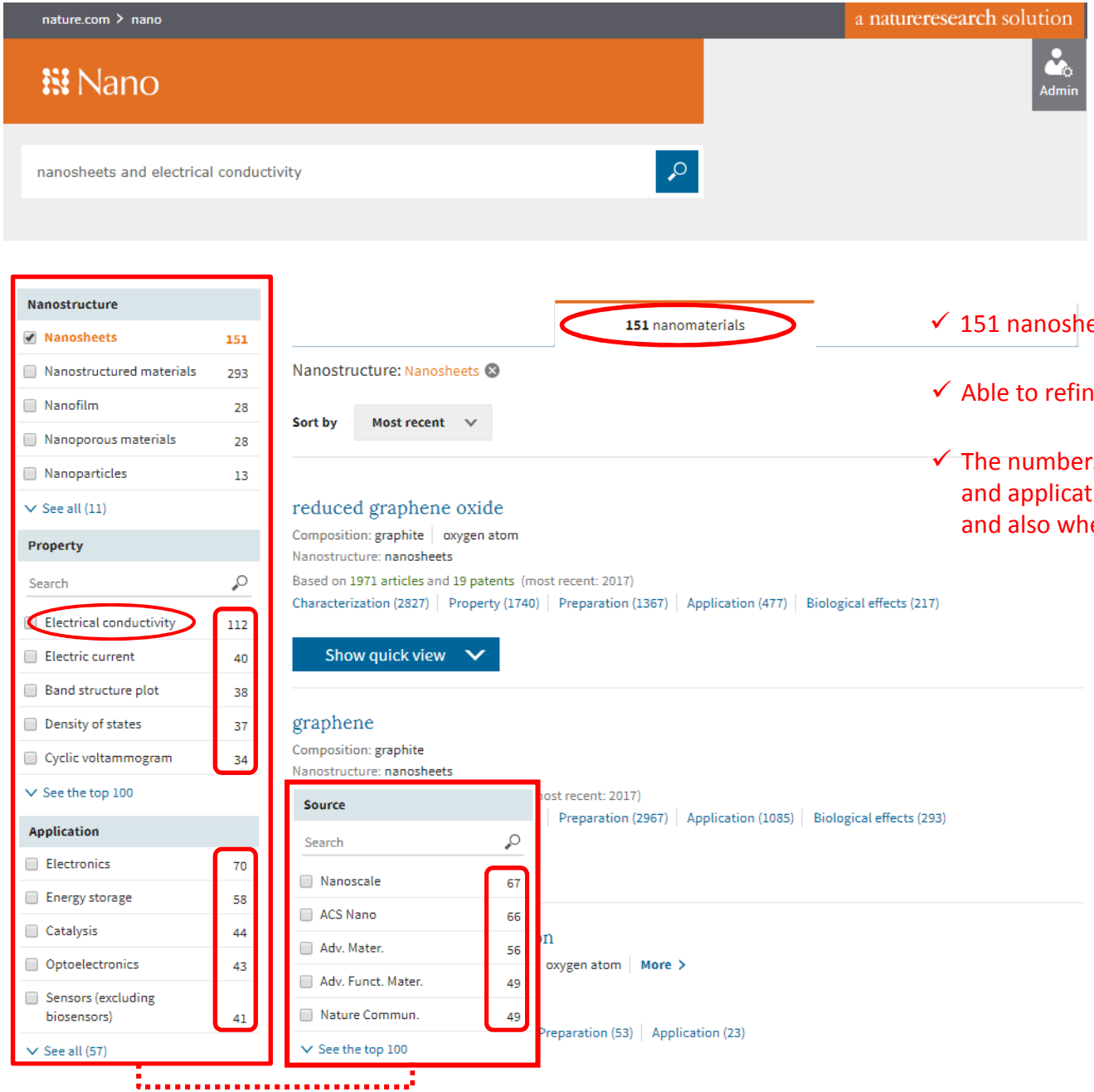
There is so much to read!!!

Are they talking about the same thing?

If not, what are the differences?

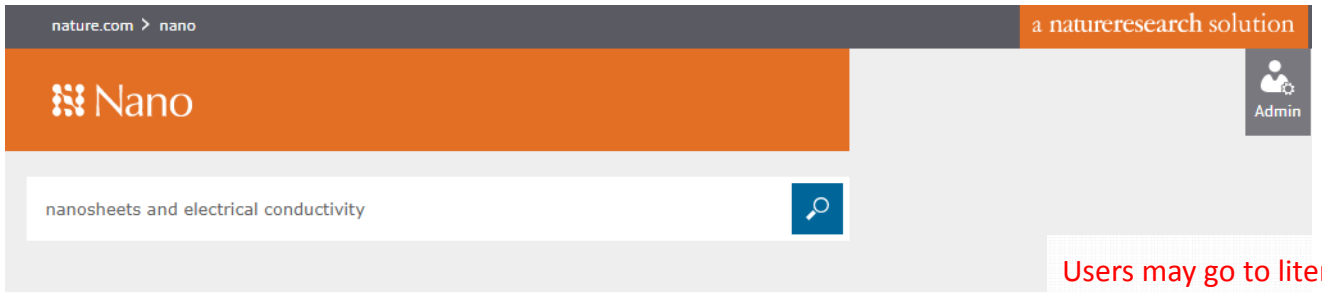
Where can I find a quick overview and drill down from there rather than going through these?

The Nano user journey for a general search



- ✓ 151 nanosheets with electrical conductivity studied
- ✓ Able to refine by property, application and source
- ✓ The numbers provide a quick overview of properties and applications that were already studied/explored, and also where these are usually published

The Nano user journey for a general search



Users may go to literatures of interest for further details and/or find other data such as applications, characterization and preparation referring to the same nanomaterial in the summary, or explore other nanosheets that conduct electricity.

Nanostructure

- Nanosheets 151
- Nanostructured materials 293
- Nanofilm 28
- Nanoporous materials 28
- Nanoparticles 13

See all (11)

Size

0 – 50000 nm

Update results

Property

Search

- Electrical conductivity 112
- Electric current 40
- Band structure plot 38
- Density of states 37
- Cyclic voltammogram 34

See the top 100

Nanostructure: Nanosheets

Sort by: Most recent

reduced graphene oxide

Composition: graphite | oxygen atom
Nanostructure: nanosheets
Based on 1971 articles and 19 patents (most
Characterization (2827) | Property (1740) |

Show quick view

graphene

Composition: graphite
Nanostructure: nanosheets
Based on 4222 articles and 134 patents (mos
Characterization (5542) | Property (4578) |

Show quick view

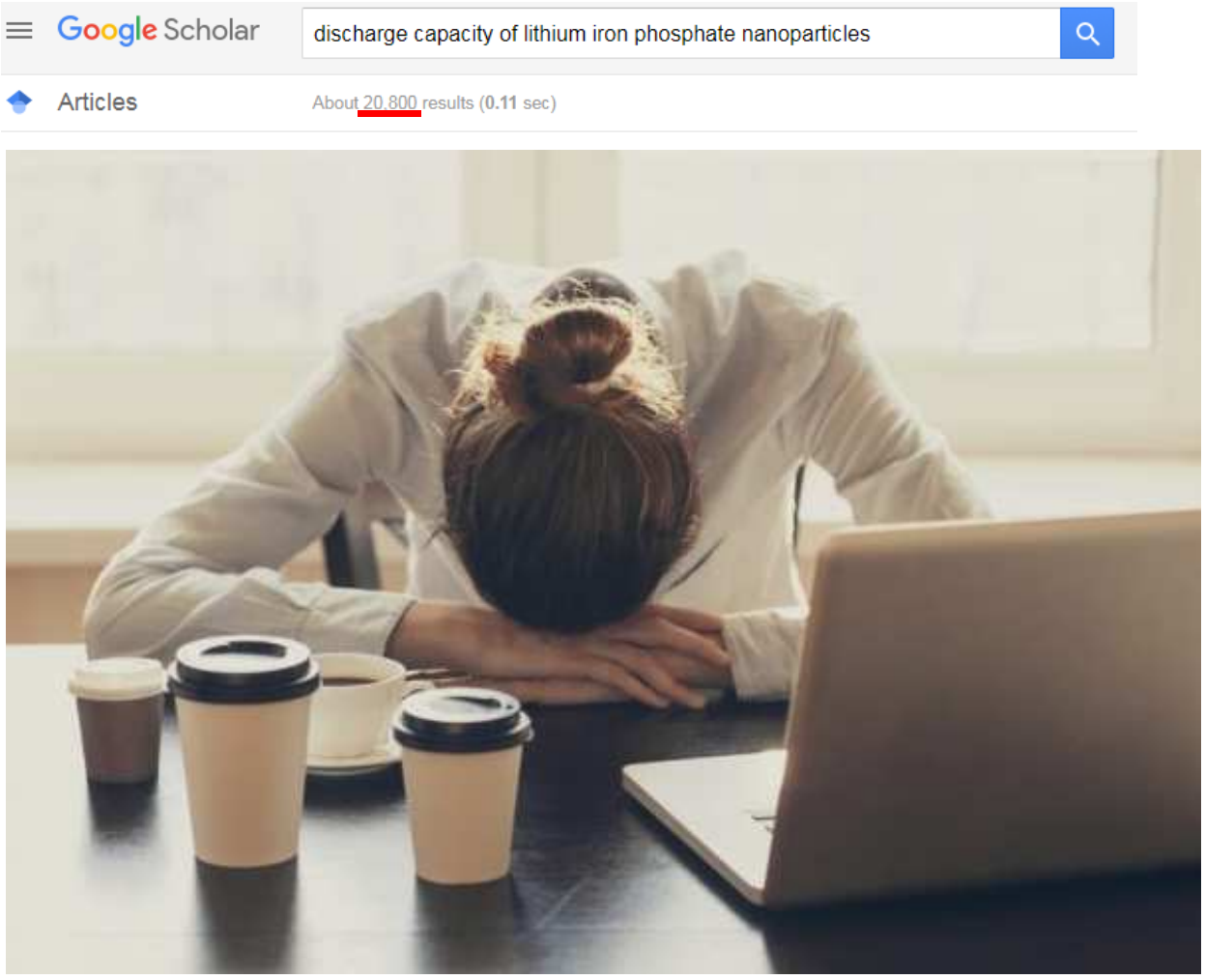
nanosheets assembled carbon

Composition: graphite | nitrogen atom | o
Nanostructure: nanosheets
Based on 38 articles (most recent: 2017)
Characterization (161) | Property (68) | Pre

Properties | Applications

Property	Value	Nanomaterial Variant	Source
electrical conductivity	250 S/m	Thickness: 0.8 nm Medium/Support: none	Experiment in Liu, Haiqing et al., Adv. Funct. Mater., 2017
	5440 S/m	Thickness: ~ 1070 nm Medium/Support: none	Experiment in Jisoo Park et al., Nanoscale, 2017
	0.0043 S/m	Size: not specified Medium/Support: none	Experiment in L. G. Guex et al., Nanoscale, 2017
	1500 S/m	Size: not specified Medium/Support: none	Experiment in L. G. Guex et al., Nanoscale, 2017
	89 S/cm [8900 S/m]	Size: not specified Medium/Support: none	Experiment in Shuwen Luo et al., Nanoscale, 2017
	75 S/m	Size: not specified Medium/Support: none	Experiment in L. G. Guex et al., Nanoscale, 2017
	120000 S/m	Lateral size: ~ 740 nm Thickness: ~ 232 nm Medium/Support: none	Experiment in Jisoo Park et al., Nanoscale, 2017
	2.27 S/cm [227 S/m]	RMS roughness: 1.2 nm Medium/Support: none	Experiment in Jung, Chan-Hee et al., Nano Energy, 2017

Case study #2 – A specific search



Relevancy

Nope

Nope

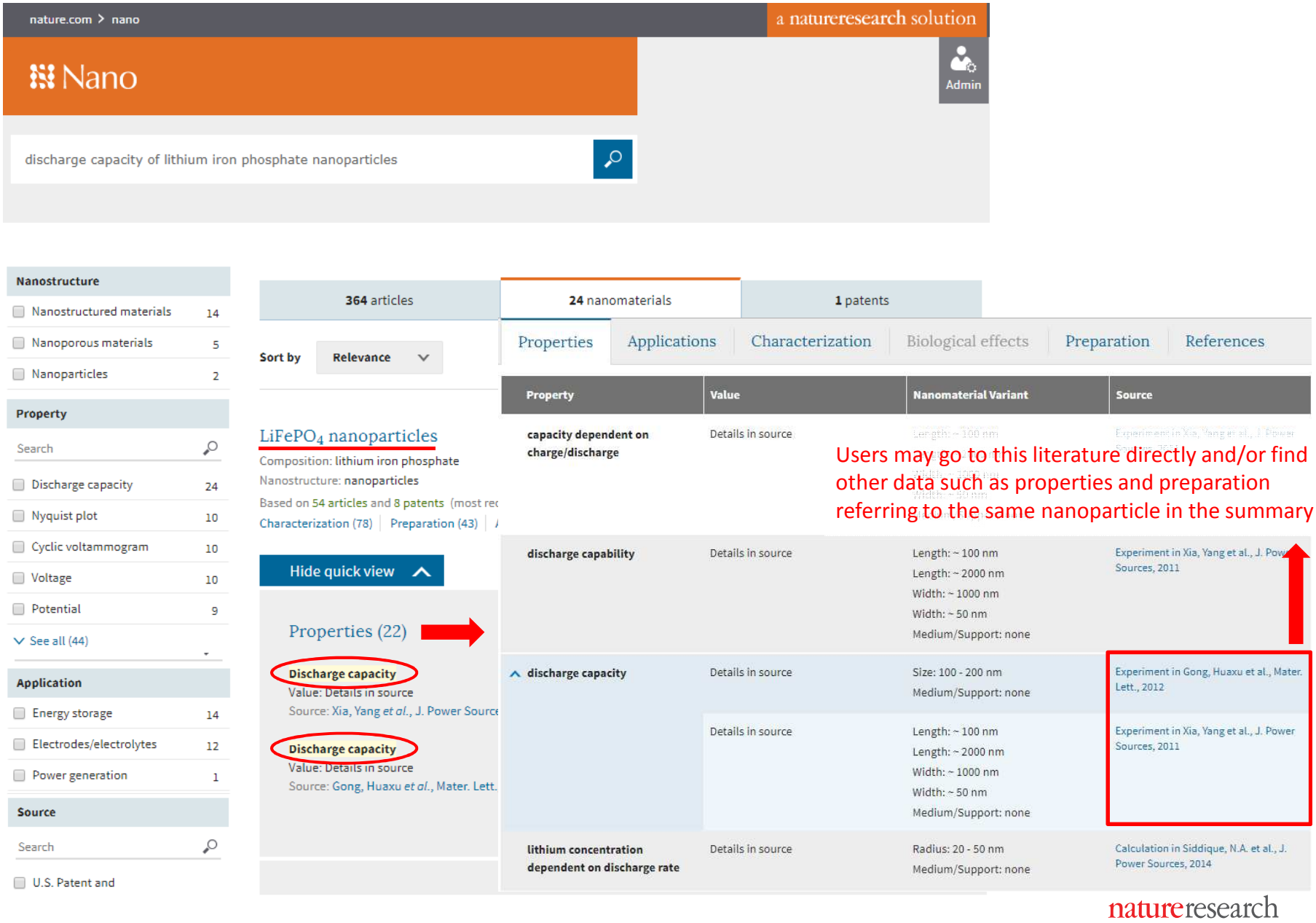
Not likely

Likely

Unsure

Not likely

The Nano user journey for a specific search



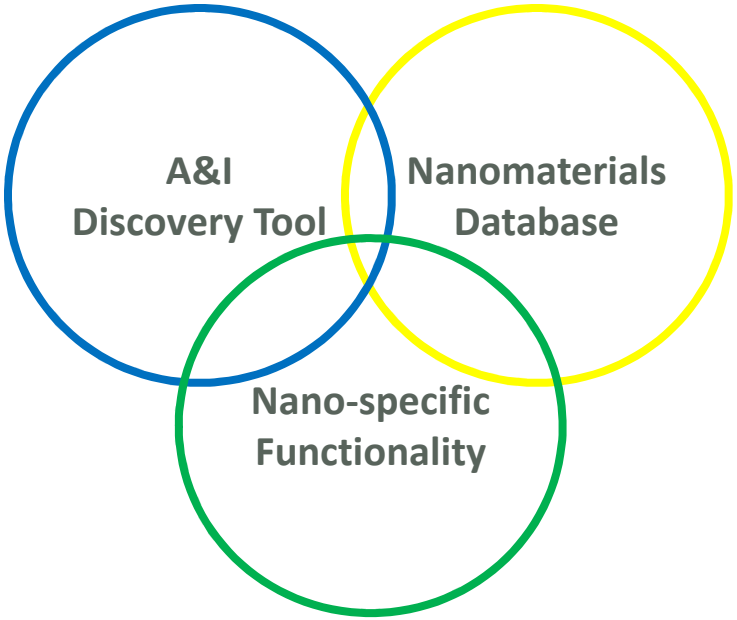
Users may go to this literature directly and/or find other data such as properties and preparation referring to the same nanoparticle in the summary

Nano

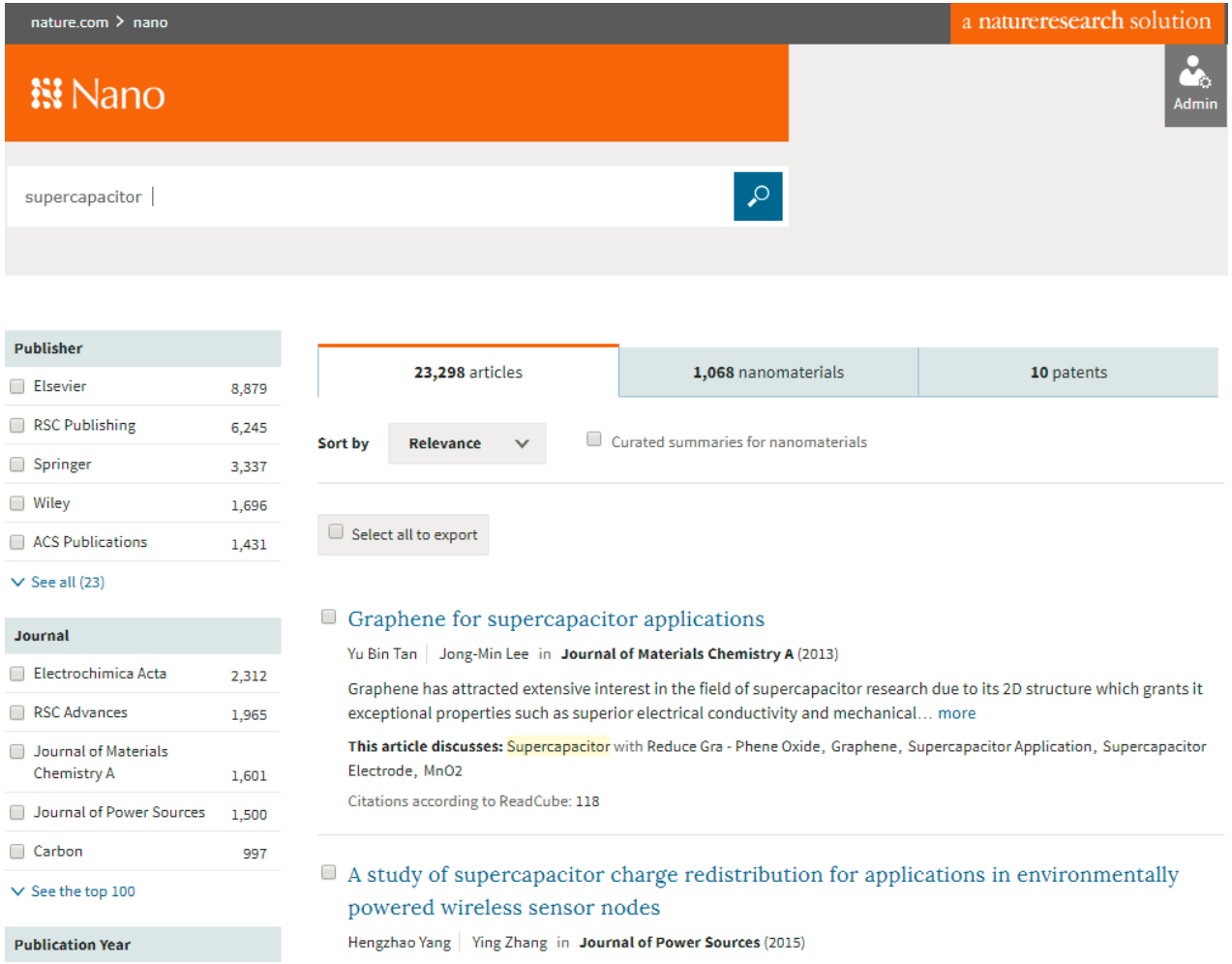
a natureresearch solution

How Nano works for you

- Advance your daily research with access to our machine-learned index of nanotechnology articles by AAAS, ACS, Elsevier, RSC, Springer Nature, Wiley and more

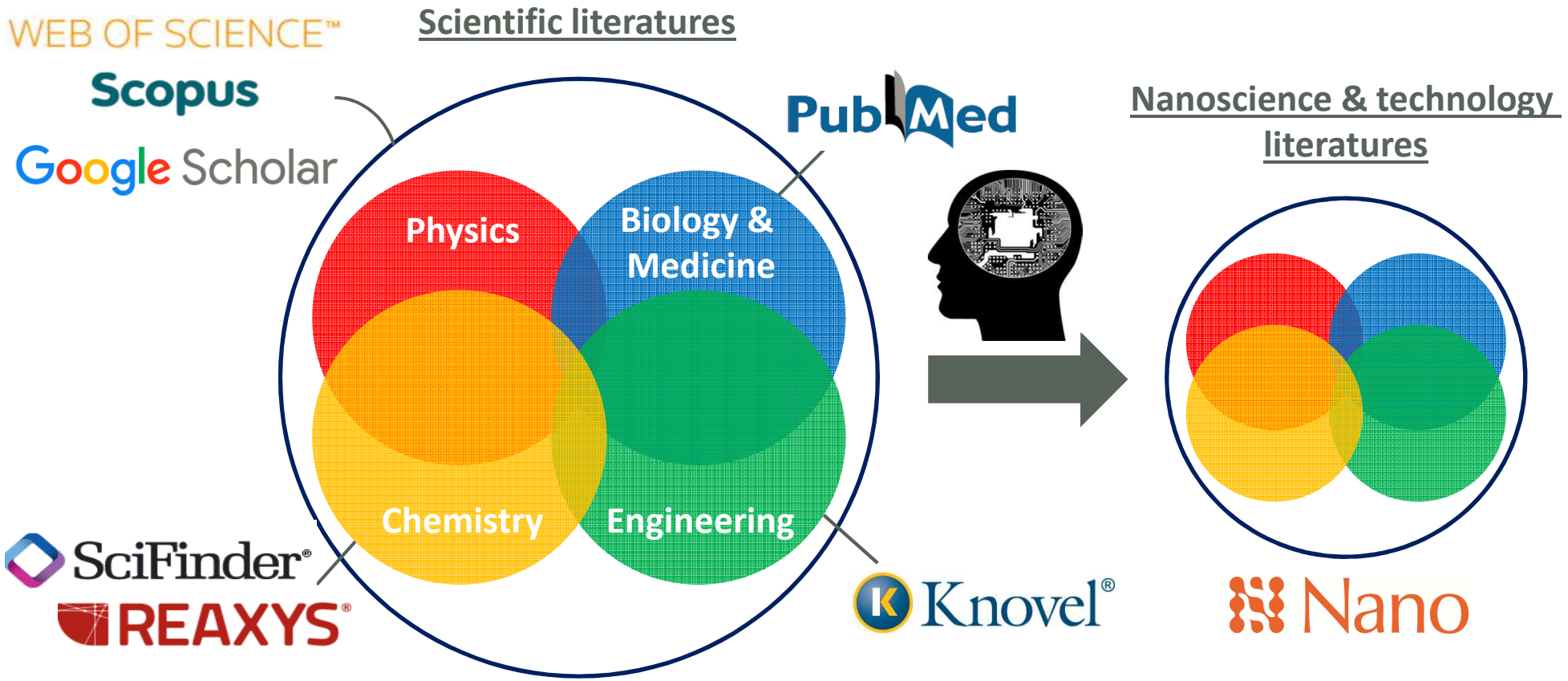


Centralized nanotech-related articles in one space



- **Keep up to date** without going to multiple journal websites and receiving multiple content alerts
- **Gain quick insights** including materials, properties and applications closely related to search input

Content coverage



Machine learning filters in nanotechnology literatures addressing user's pain point #1 – Large number of irrelevant results (See slide 9 for an example)

Indexing output

Google Scholar

The Light-Induced Field-Effect **Solar Cell** Concept–Perovskite Nanoparticle Coating Introduces Polarization Enhancing Silicon Cell Efficiency

Y Wang, Z Xia, L Liu, W Xu, Z Yuan, Y Zhang... - **Advanced** ..., 2017 - Wiley Online Library

Abstract **Solar cell** generates electrical energy from light one via pulling excited carrier away under built-in asymmetry. Doped semiconductor with antireflection layer is general strategy to achieve this including crystalline silicon (c-Si) **solar cell**. However, loss of extra energy

☆ Related articles All 3 versions

Purely word to word matching

Nano

The Light-Induced Field-Effect Solar Cell Concept – Perovskite Nanoparticle Coating Introduces Polarization Enhancing Silicon Cell Efficiency

Yusheng Wang | Zhouhui Xia | Lijia Liu ... in **Advanced Materials** (2017)

Solar cell generates electrical energy from light one via pulling excited carrier away under built-in asymmetry. Doped semiconductor with antireflection layer is general strategy to achieve this including... more

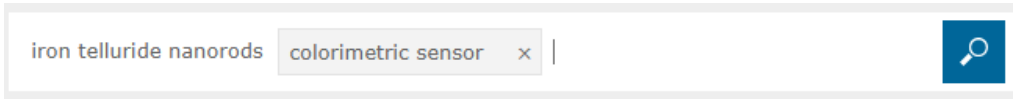
This article discusses: Solar Cell with Perovskite NPs, Power Conversion Efficiency, PSS, c-Si Solar Cell, Sunlight

Expandable abstract

Key concepts closely associated with search input

Showing concepts incl. properties and applications that are closely associated with the search input (e.g. solar cell) from the full text allows users to gain quick insight specific to the search input and identify the differences among relevant articles without the need to go into the full text – pain point #2.

Gain insight into the content that is closely related to the search input



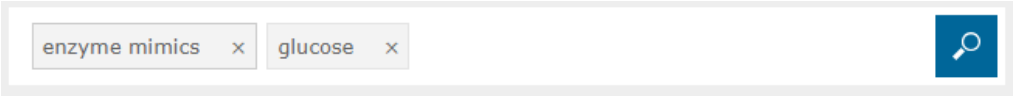
Synthesis of enzyme mimics of iron telluride nanorods for the detection of glucose

Prathik Roy | Zong-Hong Lin | Chi-Te Liang ... in **Chemical Communications** (2012)

Iron telluride nanorods (FeTe NRs, length 45 ± 11 nm) prepared from tellurium nanowires (Te NWs, length 785 ± 170) have been used to detect H_2O_2 and glucose with a limit of detection (LOD) of 55 nM (linear... more

This article discusses: Nanorods with FeTe, Te NWs, Limit Of Detection, Iron Telluride, Te Nanowires and Iron Telluride with FeTe, Te NWs, Limit Of Detection, Nanorods, Linear Range and Colorimetric Detection with FeTe, ABTS, Glucose, Fe3O4 NPs, H2O2

Citations according to ReadCube: 25



Synthesis of enzyme mimics of iron telluride nanorods for the detection of glucose

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This article discusses: Enzyme Mimic with FeTe, H2O2, Te NWs, Limit Of Detection, Iron Telluride and Glucose with FeTe, ABTS, H2O2, Glucose Concentration, Limit Of Detection

Citations according to ReadCube: 25

Quick overview of nanomaterial data curated in multiple literatures - **Properties**

gold nanoparticles

Composition: gold

Nanostructure: nanoparticles

Based on 3710 articles and 113 patents (most recent: 2017)

Characterization (3432) | Preparation (2451) | Property (1871) | Application (871) | Biological effects (724)

▾ Properties

Search for a property

General physical and chemical properties

Property	Value	Nanomaterial Variant	Source
⌄ **1,4-aminothiophenol detection analytical enhancement factor**	Details in source	Size: 30 - 60 nm Tip size: 20 nm Medium: water Support: none	Experiment in Boris Khlebtsov et al., J. Nanopart. Res., 2014
1,4-aminothiophenol detection limit	Details in source	Core size: 100 nm Size: 130 - 170 nm Tip size: 30 nm Medium: water Support: none	Experiment in Boris Khlebtsov et al., J. Nanopart. Res., 2014
100/111 surface energy ratio	Details in source	Size: 1 - 2 nm Medium/Support: none	Calculation in Almora-Barrios, Neyvis et al., Nano Lett., 2014
110/111 surface energy ratio	Details in source	Size: 1 - 2 nm Medium/Support: none	Calculation in Almora-Barrios, Neyvis et al., Nano Lett., 2014
⌄ **absorbance**	Details in source	Diameter: ~ 15.11 - 29.67 nm Medium: water Support: none	Experiment in Duy, Janice et al., J. Nanopart. Res., 2010

Quick overview of nanomaterial data curated in multiple literatures - **Applications**

gold nanoparticles

Composition: gold

Nanostructure: nanoparticles

Based on 3710 articles and 113 patents (most recent: 2017)

Characterization (3432) | Preparation (2451) | Property (1871) | Application (871) | Biological effects (724)

Applications

Search for an application area

Area	Application	Nanomaterial Variant	Source
agrochemicals	Gloriosa superba seed germination	Size: 5 - 50 nm Medium: Terminalia arjuna extract Support: none	Confirmed in K. Gopinath et al., J. Nanostruct. Chem., 2014
analysis methods	substrate for surface-enhanced Raman scattering (SERS)	Diameter: 39.5 - 75.5 nm Medium/Support: none	Confirmed in Tian, Shu et al., Nano Lett., 2017
catalysis	interfacial catalytic reactions	Core diameter: 65 nm Diameter: ~ 75 nm Spine bottom diameter: 15 nm Spine length: 5 nm Spine top diameter: 5 nm Medium/Support: none	Confirmed in Dan Wang et al., Nanoscale, 2017
coatings	plasmonic substrate	Diameter: 20 - 40 nm Interparticle distance: 5 - 10 nm Medium/Support: none	Confirmed in Lin, Linhan et al., ACS Nano, 2016
cosmetics/sunscreens/lotions	cosmetology	Size: not specified Medium: hydrogen chloride aqueous solution Support: none	Proposed in Anna Dzimitrowicz et al., J. Nanopart. Res., 2015

Quick overview of nanomaterial data curated in multiple literatures - **Characterization methods**

gold nanoparticles

Composition: gold

Nanostructure: nanoparticles

Based on 3710 articles and 113 patents (most recent: 2017)

Characterization (3432) | Preparation (2451) | Property (1871) | Application (871) | Biological effects (724)

Characterization

Search for a method

Method	Nanomaterial Variant	Source
alternating current	Diameter: ~ 20 nm Medium/Support: none	Experiment in Johannes Walter et al., Nanoscale, 2015
Analytical centrifugation	Diameter: ~ 20 nm Medium/Support: none	Experiment in Johannes Walter et al., Nanoscale, 2015
atomic absorption spectroscopy	Radius: 5 nm Medium/Support: none	Calculation in Yu Luo et al., Proc. Natl. Acad. Sci. USA, 2014
atomic force microscopy	Size: ~ 20 nm Medium/Support: none	Experiment in Satish K. Tuteja et al., Nanoscale, 2017
cathodoluminescence spectroscopy	Edge: 50 nm Thickness: 50 nm Medium/Support: none	Calculation in Losquin, Arthur et al., Nano Lett., 2015

Quick overview of nanomaterial data curated in multiple literatures - **Toxicity and biological effects**

gold nanoparticles

Composition: gold

Nanostructure: nanoparticles

Based on 3710 articles and 113 patents (most recent: 2017)

Characterization (3432) | Preparation (2451) | Property (1871) | Application (871) | Biological effects (724)

Biological effects

Search for a biological system

Biological system	Test details	Nanomaterial Variant	Source
3-D mouse kidney proximal tubule culture	nontoxic	Size: not specified Medium/Support: none	Astashkina, Anna I. et al., Biomaterials, 2014
3T3-L1 cells	noncytotoxic	Diameter: 25 nm Medium/Support: none	Park, Hyejin et al., Biomaterials, 2014
4T1 cells	noncytotoxic	Diameter: 80 nm Medium/Support: none	Liu, Zhen et al., Biomaterials, 2014
4T1 tumor-bearing athymic female BALB/c nude mouse	no effect on body weight, intravenous (iv)	Size: not specified Medium/Support: none	Du, Yang et al., Adv. Mater., 2016
4T1-fLuc tumor cells	cytotoxic upon NIR laser irradiation	Size: not specified Medium/Support: none	Du, Yang et al., Adv. Mater., 2016

Quick overview of nanomaterial data curated in multiple literatures - **Preparation**

gold nanoparticles

Composition: gold

Nanostructure: nanoparticles

Based on 3710 articles and 11

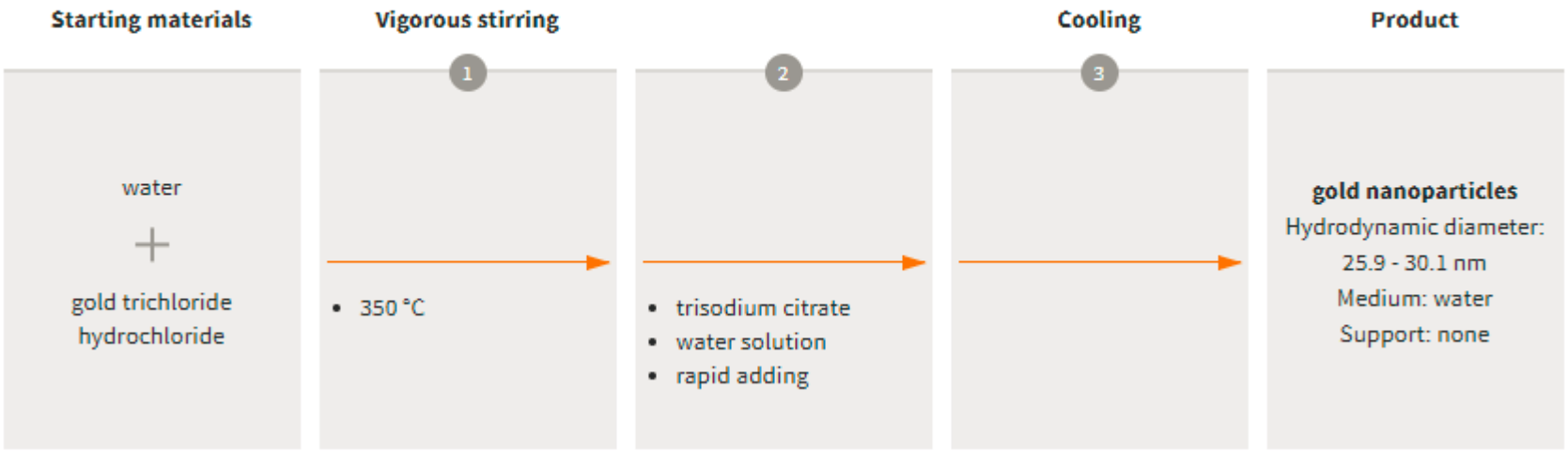
Characterization (3432) | Pre

4.2. Synthesis of gold nanoparticles

AuNPs (20 ± 3 nm; Fig. S12B†) were prepared with the sodium citrate method.[43,48] $HAuCl_4$ (1.25 mL, 4 g L^{-1}) was added into 48.75 mL of ultrapure water with vigorous stirring, and boiled at a high temperature (350 °C). After several minutes, freshly prepared aqueous trisodium citrate solution (1.2 mL, 10 mg mL^{-1}) was added rapidly. After the color of the solution had stabilized, the reaction solution was cooled to room temperature and then stored at 4 °C.

Preparation

Type: Chemical synthesis **Source:** Aihua Qu et al., Nanoscale, 2017



Journal selection is mainly based on inputs from research communities and Nature editors

Data from high-impact journals in the field including:

- *ACS Nano,* ACS
- *Advanced Energy Materials,* Wiley
- *Advanced Materials,* Wiley
- *Angewandte Chemie International Edition,* Wiley
- *Biomaterials,* Elsevier
- *Chemistry of Materials,* ACS
- *Journal of the American Chemical Society,* ACS
- *Nano Energy,* Elsevier
- *Nanomedicine: Nanotechnology,* Biology *and Medicine,* Elsevier
- *Nano Letters,* ACS
- *Nanoscale,* RSC
- *Nanotoxicology,* Taylor & Francis
- *Nature,* Nature Research
- *Nature Materials,* Nature Research
- *Nature Nanotechnology,* Nature Research
- *Proceedings of the National Academy of Sciences of the United States of America, PNAS*
- *Science,* AAAS
- *Small,* Wiley

Nano is a user proven solution

- Early market research based on 218 online survey respondents and 28 in-depth phone interviews gave us the confidence to start this ambitious project. One general feedback is “Building a nanoscience-dedicated discovery tool is a great idea!”
- We have been conducting multiple rounds of user testing to ensure platform functionalities and features serve practical purposes and add values to the users.

117 nano researchers across the globe have participated in user testing to date

Nano Advisory Board (more to come)

Jens Kroeger, PhD
Chief Technology Officer
Raymor industries and NanoIn

Seeram Ramakrishna, PhD
Professor
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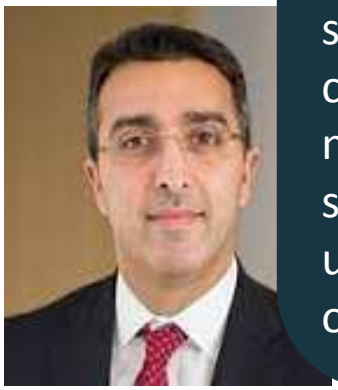
Nano is an emerging and very powerful research tool. It allows researchers to obtain and compare the characteristics of the full spectrum of nanomaterials, as well as the composition and preparation methods for nano-enabled devices. It will provide nano-scientists with the clarity and deep understanding that the Mendeleev table once provided to chemists.



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Thank You !

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