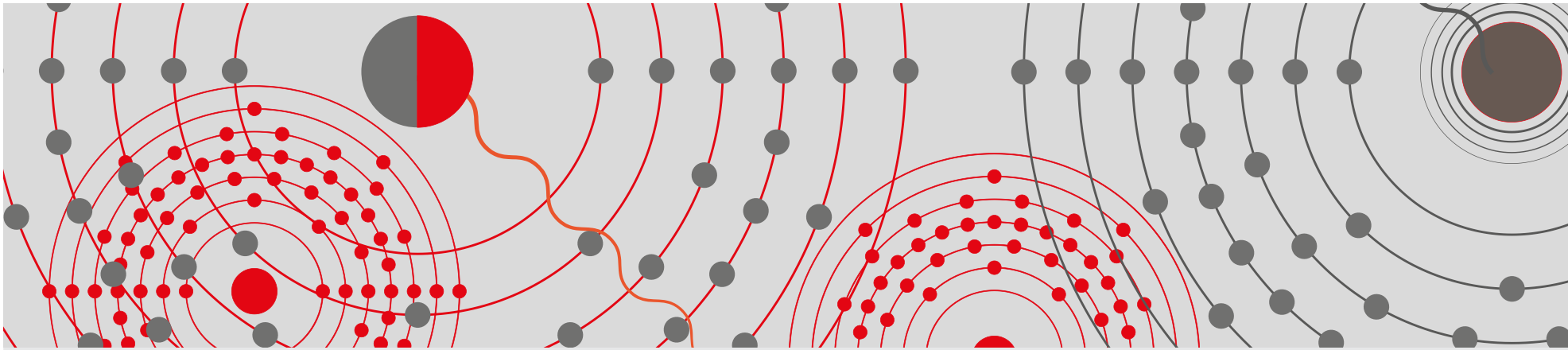
Part of SPRINGER NATURE

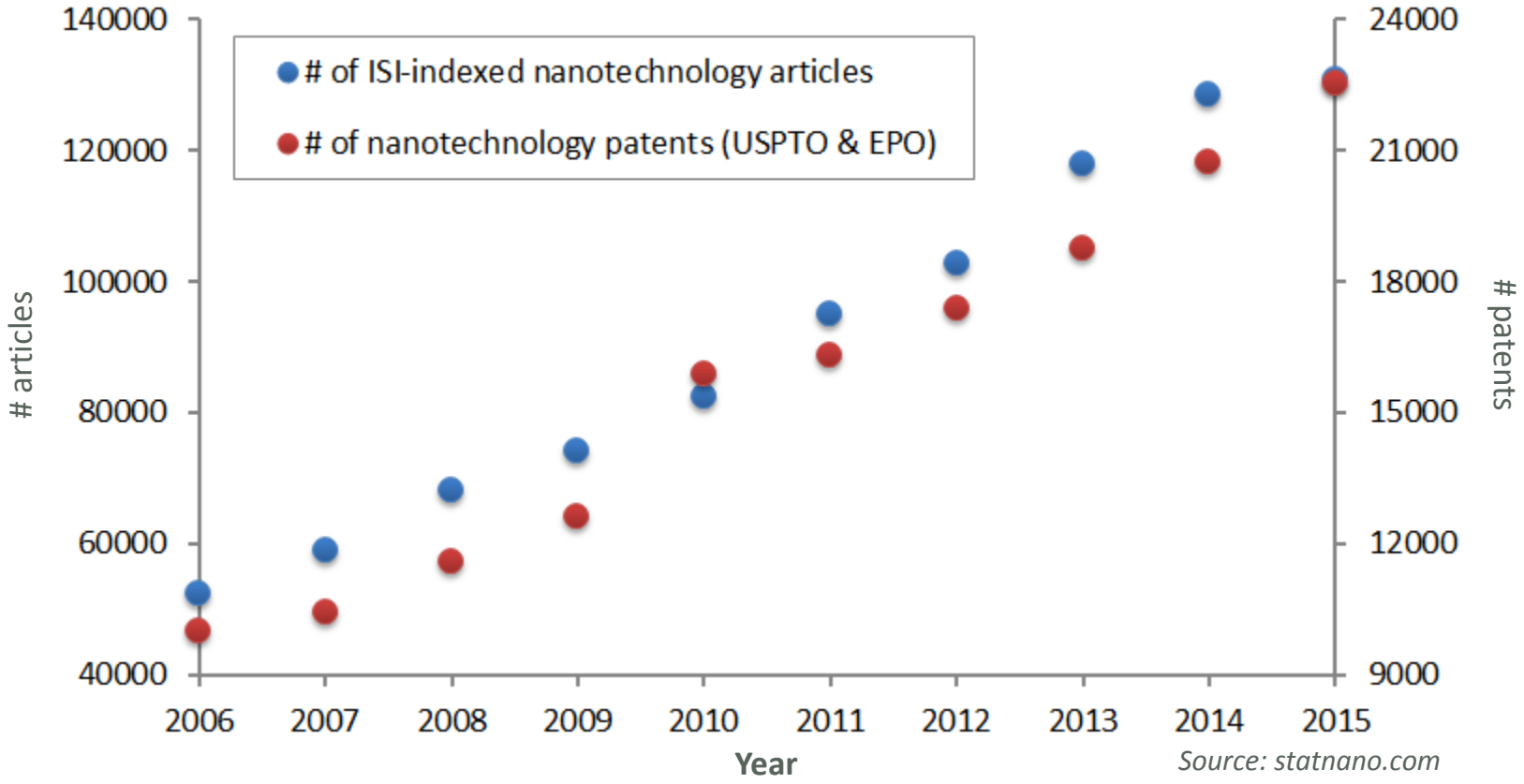


Nano

a nature research solution

nature research

Nanoscience & technology - a booming field



- 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

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 nanosheets and electrical conductivity

Scholar About 62,300 results (0.08 sec)

Articles
Case law
My library

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 7935 Related articles All 19 versions Cite Save

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 5648 Related articles All 15 versions Cite Save

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 191 Related articles All 8 versions Cite Save

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 2474 Related articles All 15 versions Cite Save

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 163 Related articles All 15 versions Cite Save

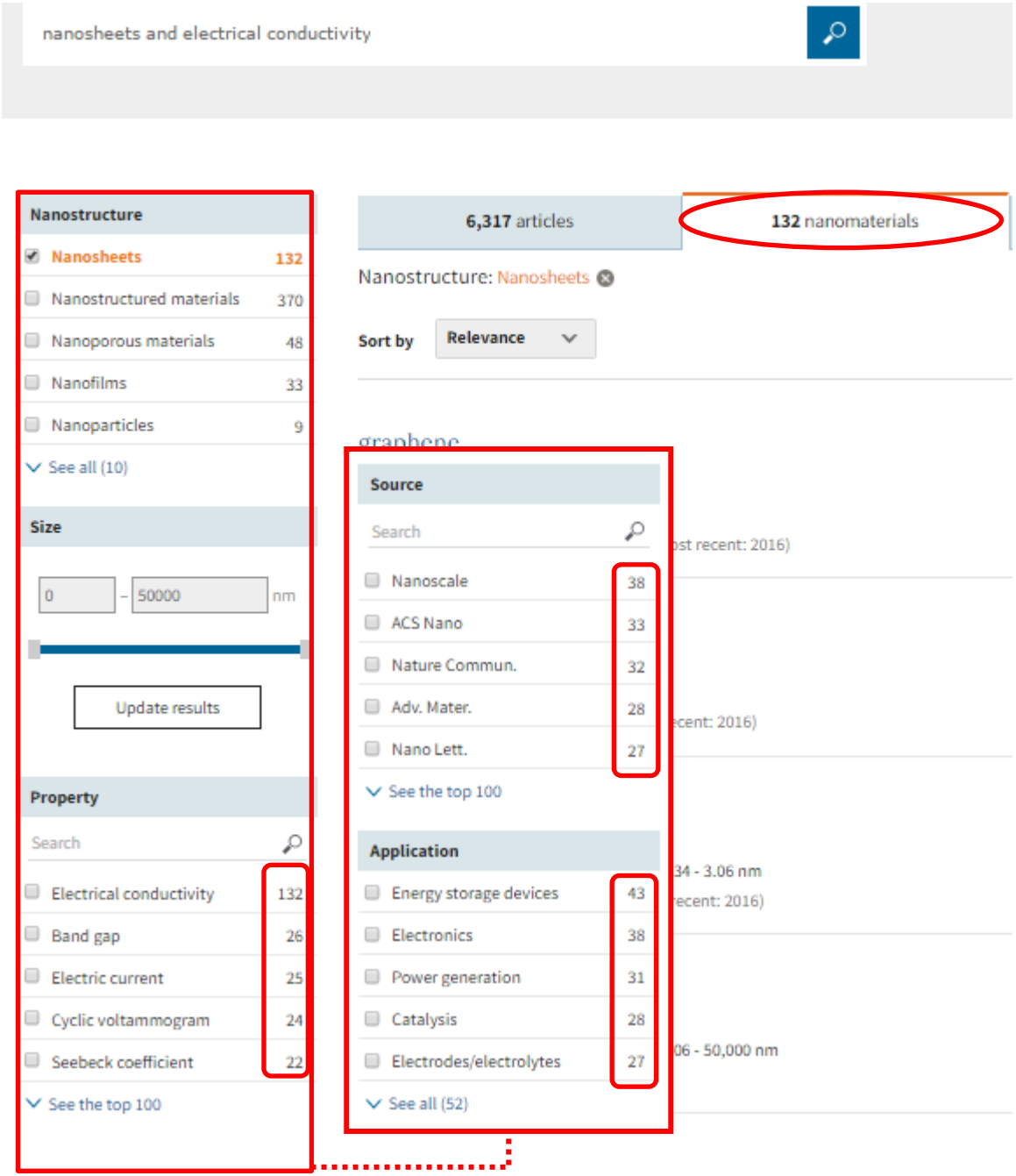
There is so much to read!!!

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



- ✓ 132 nanosheets with electrical conductivity studied
- ✓ Able to refine by size, property, source and application
- ✓ 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

nanosheets and electrical conductivity

Nanostructure

- Nanosheets 132
- Nanostructured materials 370
- Nanoporous materials 48
- Nanofilms 33
- Nanoparticles 9

See all (10)

Size

0 – 50000 nm

Update results

Property

Search

- Electrical conductivity 132
- Band gap 26
- Electric current 25
- Cyclic voltammogram 24
- Seebeck coefficient 22

See the top 100

6,317 articles | **132** nanomaterials

Nanostructure: Nanosh

Sort by **Relevance**

graphene

Composition: graphite
Nanostructure: nanosheets
Based on 3207 articles and

MoS_2 nanosheets

Composition: molybdenum
Nanostructure: nanosheets
Based on 591 articles and

graphene

Composition: graphite
Nanostructure: nanosheets
Based on 151 articles and

SnS_2 nanosheets

Composition: tin disulfide
Nanostructure: nanosheets | Thickness: 3.06 - 50,000 nm
Based on 14 articles (most recent: 2016)

Properties

General physical and chemical properties

Property	Value	Measurement parameter	Determined by	Source
conductance	0.00000286 - 0.059 S	–	experiment	Nassira, Hoda *et al.* 2016
conductance	~ 0.00105 S	–	experiment	Lee, Seong Kyu *et al.* 2014
electrical conductivity	276 S/m	–	experiment	Zhu, Lin *et al.* 2015
electrical conductivity	334,000 S/m	–	experiment	Rubén Rozada *et al.* 2013
electrical conductivity	518,000 S/m	–	experiment	Jing Liu *et al.* 2016
electrical conductivity	2,050,000 S/m	–	experiment	Jing Liu *et al.* 2016
electrical conductivity	11,500 S/cm [1,150,000 S/m]	–	experiment	Chen, Mingguang *et al.* 2016
electrical conductivity	104 S/m	–	experiment	Li, Zhuo *et al.* 2015
electrical conductivity	~ 1,000 S/cm [~ 100,000 S/m]	–	experiment	Shen, Bin *et al.* 2014
electrical conductivity	3,160,000 S/m	–	experiment	Jing Liu *et al.* 2016
electrical conductivity	218,000 S/m	–	experiment	Rubén Rozada *et al.* 2013

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

Case study #2 – A specific search

Google discharge capacity of lithium iron phosphate nanoparticles

Scholar About 16,300 results (0.08 sec)

Articles
Case law
My library

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

Sort by relevance
Sort by date

include patents
include citations

Create alert

Nanoparticle iron-phosphate anode material for Li-ion battery
D Son, E Kim, TG Kim, MG Kim, J Cho... - Applied Physics ..., 2004 - aip.scitation.org
... **phosphates** exhibited an open circuit **voltage** of approximately 4 V, and showed a **voltage** plateau at ~ 3 V (working as cathodes) with **discharge capacities** below 100 ... synthesized **nanoparticle iron phosphates** is approximately three times higher than the ideal **capacity** of the ...
Cited by 84 Related articles All 9 versions Cite Save

Relevancy

Nope

Nope

Not likely

Likely

Likely

The Nano user journey for a specific search

discharge capacity of lithium iron phosphate nanoparticles

Nanostructure

- Nanostructured materials 15
- Nanoporous materials 5
- Nanoparticles 4

Size

2 – 50000 nm

Update results

Property

Search

- Discharge capacity 26
- Cyclic voltammogram 12
- Nyquist plot 11

169 articles | **26** nanomaterials

Sort by Relevance

$LiFePO_4$ nanoparticles

Composition: LFP
Nanostructure: nanoparticles | Diam
Based on 10 articles and 2 patents (m

$LiFePO_4$ nanoparticles

Composition: lithium iron phosphate
Nanostructure: nanoparticles
Based on 14 articles and 4 patents (m

$LiFePO_4$/C nanoparticles

Composition: LFP | carbon
Nanostructure: nanoparticles | Diam
Based on 11 articles and 2 patents (most recent: 2016)

Properties

General physical and chemical properties

Property or diagram	Availability	Measurement parameter	Determined by	Source
capacity	value given	charge/discharge	experiment and calculation	Xia, Yang *et al.* 2011
cyclic stability	value given	–	experiment and calculation	Xia, Yang *et al.* 2011
discharge capability	value given	–	experiment and calculation	Xia, Yang *et al.* 2011
discharge capacity	value given	–	experiment and calculation	Xia, Yang *et al.* 2011
electric current	value given	cycle number	experiment and calculation	Xia, Yang *et al.* 2011
Nyquist plot	value given	before/after 50 cycles	experiment and calculation	Xia, Yang *et al.* 2011
reversible capacity	value given	current flow rate	experiment and calculation	Xia, Yang *et al.* 2011
structural stability	value given	–	experiment and calculation	Xia, Yang *et al.* 2011
voltage	value given	cycle number current flow rate	experiment and calculation	Xia, Yang *et al.* 2011

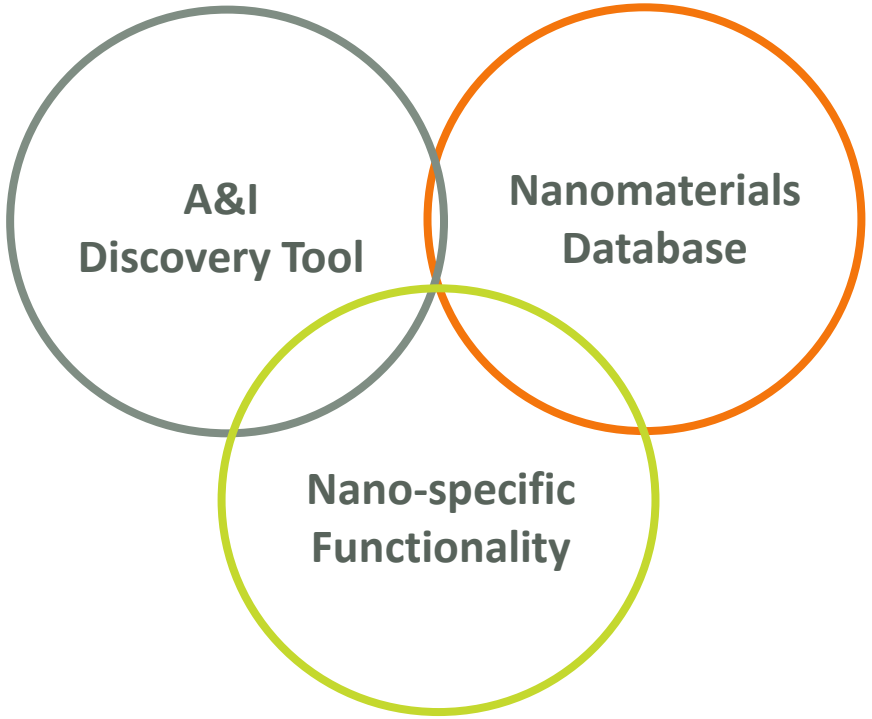
Users may go to this literature directly and/or find other data such as properties and preparation referring to the same nanoparticle in the summary

Nano

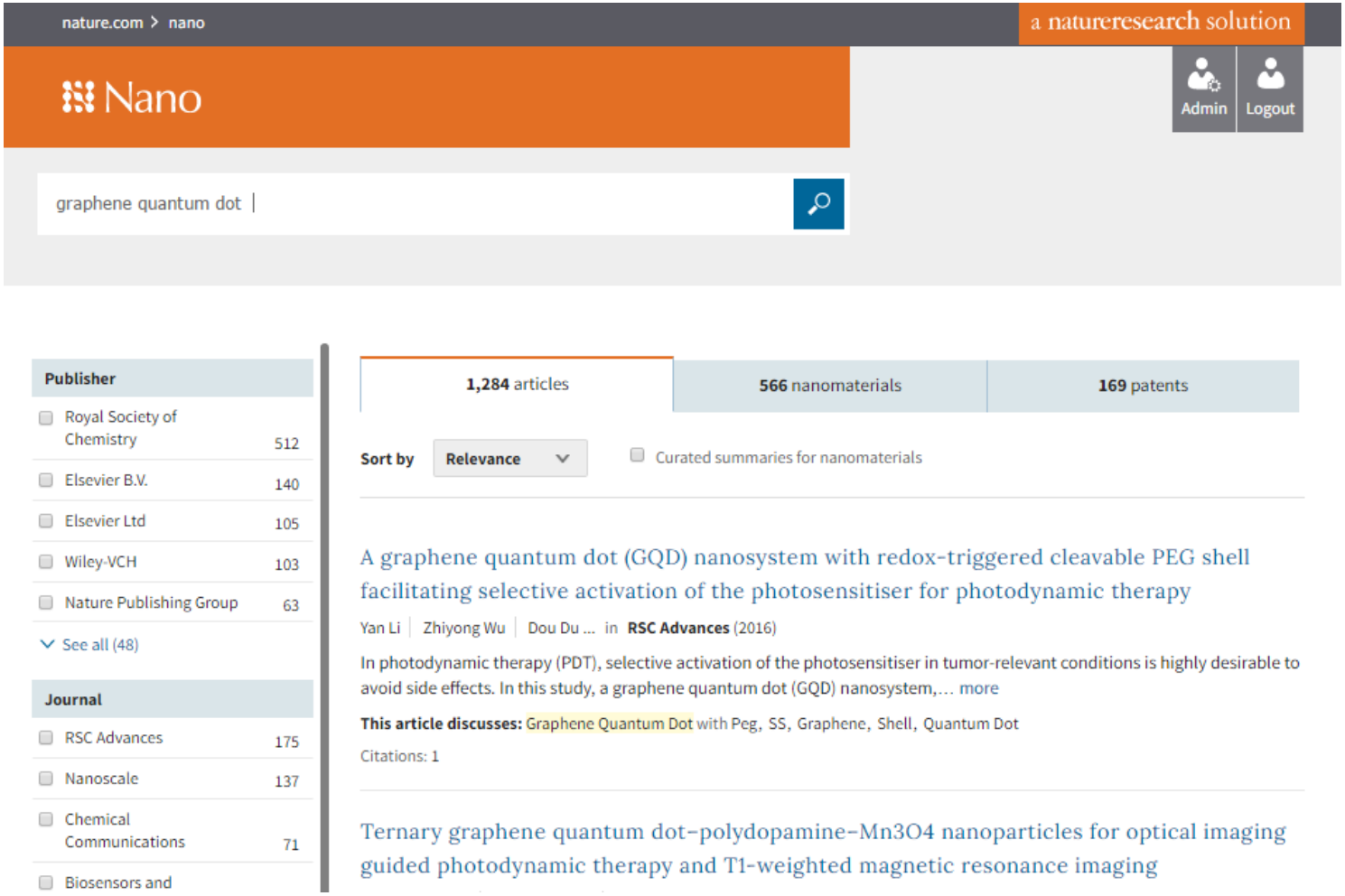
a natureresearch solution

1. Nano (URL:**nano.nature.com**) provides highly indexed and structured information related to nanotechnology derived from high impact journals and patents.

2. Nano combines the key features of a database and an A&I discovery tool supported by intelligent functionality.



Centralized nanotech-related articles in one space



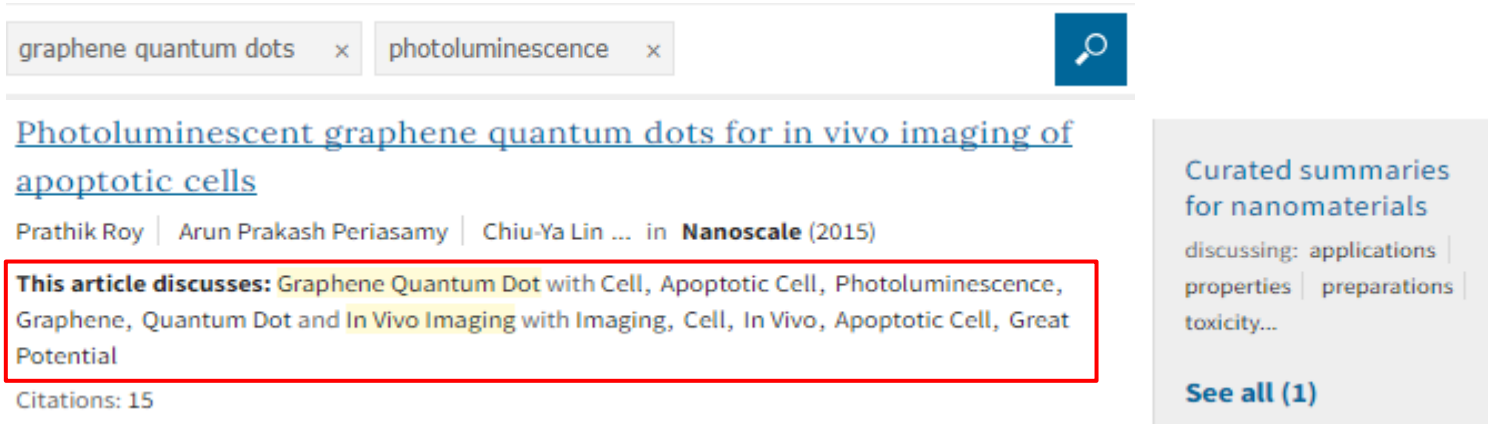
- **Keep up to date** without going to multiple journal websites and receiving multiple content alerts
- **Gain quick insights** including materials, properties and applications closely related to search input

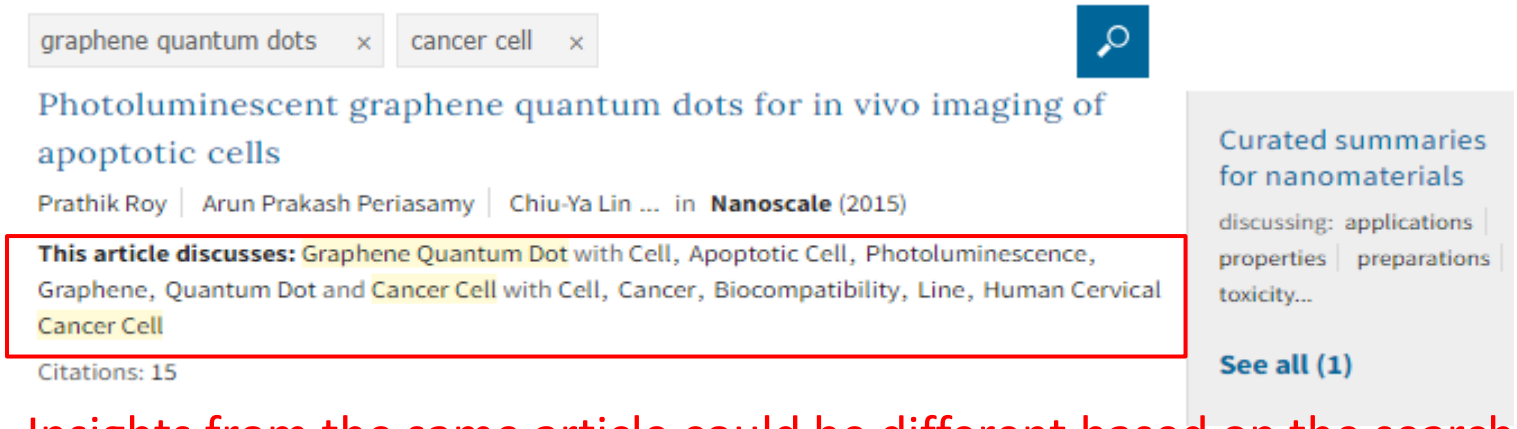
Journal selection is mainly based on inputs from research communities and Nature editors

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

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





Insights from the same article could be different based on the search inputs

Quick overview of nanomaterial data reported in multiple literatures – **Properties**

gold nanoparticles

Composition: gold

Nanostructure: nanoparticles | Diameter: 0 - 30 nm

Based on 1576 articles and 23 patents (most recent: 2016)

Properties

General physical and chemical properties

Property	Value	Measurement parameter	Determined by	Source
electrical conductivity	0.06 S/cm [6 S/m]	–	experiment	Yilmaz, Cihan *et al.* 2014
electrical conductivity	0.0000836 S/cm [0.00836 S/m]	–	experiment	Haisheng Peng *et al.* 2015
electrical conductivity	~ 0.012 S/cm [~ 1.2 S/m]	–	experiment	Glen DeLoid *et al.* 2014
electrical resistance	1,470 Ω	–	calculation	Yilmaz, Cihan *et al.* 2014
electrical resistance	11.9 Ω	–	calculation	Yilmaz, Cihan *et al.* 2014

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

gold nanoparticles

Composition: gold

Nanostructure: nanoparticles | Diameter: 0 - 30 nm

Based on 1576 articles and 23 patents (most recent: 2016)

Characterization

Spectroscopic analysis

Method	Dependent on	Values given	Spectrum given	Calculated	Source
Photon correlation spectroscopy See all names (4)	time	Yes	Yes	Yes	A. R. M. Nabiul Afrooz *et al.* 2014 Feng Chen *et al.* 2014
Photon correlation spectroscopy See all names (4)	–	Yes	Yes	Yes	Stadler, Andrea L. *et al.* 2011 Zhang, Peipei *et al.* 2015 Jayachandra Reddy Nakkala *et al.* 2015 Wang, Jie *et al.* 2015 M. Zimbone *et al.* 2012 Nam, Sun-Hwa *et al.* 2015 Marioara Avram *et al.* 2012 In-Cheol Sun *et al.* 2014 Tetienne, Jean-Philippe *et al.* 2016

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

gold nanoparticles

Composition: gold

Nanostructure: nanoparticles | Diameter: 0 - 30 nm

Based on 1576 articles and 23 patents (most recent: 2016)

Toxicity and other biological effects

Test outcome	Biological system	Test route	Pharmacodynamic parameter	Source
acceleration of cell migration	Rat Glioma 2 cell	–	–	Rahman, Wan *et al.* 2011
acceleration of cell migration	bovine aortic endothelial cell	–	–	Rahman, Wan *et al.* 2011
accumulate at the plasma membrane	HeLa cells	–	–	Li Shang *et al.* 2014
accumulation in gut	Daphnia magna	–	–	Kyle D. Gilroy *et al.* 2014
aggregation induction	blood platelets	–	–	Santos-Martinez MJ *et al.* 2012

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

gold nanoparticles

Composition: gold

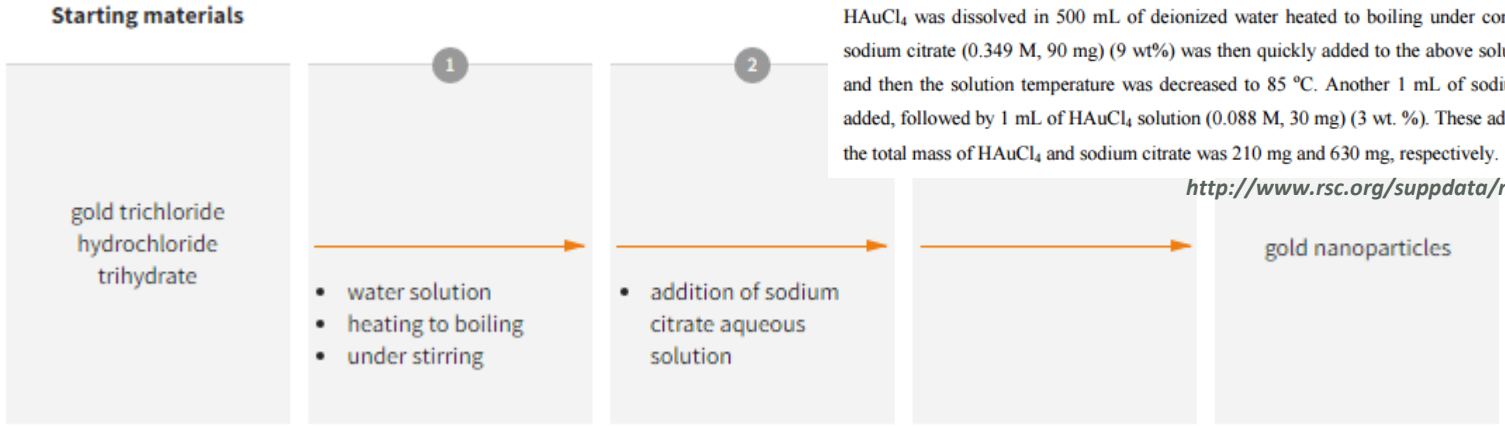
Nanostructure: nanoparticles | Diameter: 0 - 30 nm

Based on 1576 articles and 23 patents (most recent: 2016)

Preparation

Synthesis

Type: Chemical synthesis **Source:** Weikun Li *et al.* 2015 (*Nanoscale*)



3. Synthesis, surface modification and self-assembly of AuNPs

3.1 Synthesis of AuNPs

The glassware for AuNP synthesis were cleaned by aqua regia and rinsed with deionized water prior to all experiments. AuNPs with size of 8.5±0.7 nm were synthesized by seeding growth approach.[2] To prepare the seed solution of AuNPs, 4.9 mg of $HAuCl_4$ (0.014 mmol) and 3.7 mg of sodium citrate (0.013 mmol) were first dissolved in a 100 mL of aqueous solution. 1.5 mL of ice-cold, freshly prepared 0.1 mol/L of $NaBH_4$ (0.15 mmol) solution was quickly injected into the solution under strong stirring. The seed solution was stirred for an additional 2 hr. For 8.5±0.7 nm AuNP, the growth solution was prepared by mixing 144 mL of a 0.2 M CTAB (10.48 g) solution was mixed with 9 mL of a $HAuCl_4$ aqueous solution 10 mM (30.6 mg). To the above solution, 2.4 mL of ascorbic acid solution (0.1 M, 42.2 mg) was added dropwise and the dark yellow solution turned colorless. Finally, 75 mL of a 2-hour-aged seed solution of AuNPs was added to the above growth solution. After growth for 3 hr, AuNPs with size of 8.5±0.7 nm were obtained.

AuNPs with size of 15.1±1.0 nm were synthesized by the previously reported citrate reduction method.[3] Briefly, a 10 mg of $HAuCl_4$ was dissolved in 100 mL of deionized water and heated to boiling under stirring. A 3 mL of sodium citrate (1 wt %) aqueous solution was then quickly added in the above solution. After refluxed for 30 min, AuNPs with size of 15.1 ± 1.0 nm were obtained.

To synthesize AuNPs with a size of 29.6 ± 2.8 nm,[4] initially, AuNPs with size of 15.1±1.0 nm were used as seeds. 30 mg of $HAuCl_4$ was dissolved in 500 mL of deionized water heated to boiling under constant stirring. A 1 mL aqueous solution of sodium citrate (0.349 M, 90 mg) (9 wt%) was then quickly added to the above solution. The solution was refluxed for 30 min, and then the solution temperature was decreased to 85 °C. Another 1 mL of sodium citrate (0.349 M, 90 mg) (9 wt %) was added, followed by 1 mL of $HAuCl_4$ solution (0.088 M, 30 mg) (3 wt. %). These additions were repeated every 15 minutes until the total mass of $HAuCl_4$ and sodium citrate was 210 mg and 630 mg, respectively.

http://www.rsc.org/suppdata/nr/c4/c4nr05743k/c4nr05743k1.pdf

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

gold nanoparticles

Composition: gold

Nanostructure: nanoparticles | Diameter: 0 - 30 nm

Based on 1576 articles and 23 patents (most recent: 2016)

Applications

Application	Area	Specific application	Experimentally confirmed	Source
anti-angiogenesis agent	medicine/veterinary	–	no	El-Said, Waleed A. *et al.* 2014
anti-arthritic agent	medicine/veterinary	–	no	El-Said, Waleed A. *et al.* 2014
anti-malaria agent	medicine/veterinary	–	no	El-Said, Waleed A. *et al.* 2014
antibacterial	medicine/veterinary	–	no	S. L. Smitha *et al.* 2012
antibacterial	disinfection	against Escherichia coli ATCC 35218 and Streptococcus mutans MTCC 497	no	Eepsita Priyadarshini *et al.* 2014
antibacterial	medicine/veterinary	–	yes	S. L. Smitha *et al.* 2012

Quick overview of nanomaterial data reported in multiple literatures - **Patent claims**

gold nanoparticles

Composition: gold

Nanostructure: nanoparticles | Diameter: 0 - 30 nm

Based on 1576 articles and 23 patents (most recent: 2016)

Patent claims

Patent	Claim numbers	Claims	Synthesis information
U.S. patent US20150086416, 26 Mar 2015	–	A specific method of preparation is claimed for the described nanomaterial	Available
PCT patent WO/2014/055539, 10 Apr 2014	–	–	Available
PCT patent WO/2014/045055, 27 Mar 2014	–	The nanomaterial is claimed together with its method of preparation A specific method of preparation is claimed for the described nanomaterial	Available
PCT patent WO/2014/039821, 13 Mar 2014	–	A specific method of preparation is claimed for the described nanomaterial	Available
U.S. patent US20120244322, 27 Sep 2012	–	The nanomaterial is claimed	–

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.

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

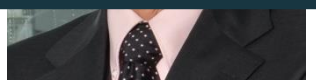
Nano Advisory Board (more to come)

Jens Kroeger, PhD
Chief Technology Officer
Raymor industries and NanoIntegris

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.

Omid Farokhzad, MD
Assoc. Prof.
Brigham and Women's Hospital
Harvard Medical School

Zhiyong Tang, PhD
Prof. of Materials Chemistry
NCNST, CAS



Harald Krug, prof.
Swiss Federal Laboratories for
Materials Science and Technology

Thank You !

For more information, visit: **nano.nature.com**.

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