ADVANCED MATERIALS

EMFUTUR

technologies

NANOTECHNOLOGY is becoming the basis of the main technological innovations of the 21st century. Research and development in this field is growing rapidly throughout the world.
A major output of this activity is the development of **new materials in the nanometer scale**, including nanoparticles.
Material properties and functionality of the bulk tend to differ significantly when one or more of its dimensions are reduced down to between **100 to 1 nm**, the so called *"nanosize range"*.

The basic classes of nanomaterials are:
- Thin films (two dimensional, or 2D)
- Nanowires / nanotubes (one dimensional, or 1D)
- Nanoparticles / quantum dots (zero dimensional, or 0D)

Nanomaterial frameworks have been focused on structural designs, synthetic methods, characterizations, size-dependent properties and their applications. A number of applications in optics, electronics, sensing, photonic, magnetism, mechanics, self-assembly, catalysis and biomedicine have been extensively researched, yet challenges remain to combine each individual property into one multi-functional nanostructure and advance its use based upon that unique property.

EMFUTUR technologies
- Is providing the highest quality supplies for these future developments.
- Is a high quality Nanomaterials supplier.
- Offers nanoparticles, nanopowders, micron powders, Graphene and CNTs (carbon nanotubes) in small quantity for researchers and in bulk order for industry groups.
- Product quality emphases the significance of purest Nanomaterials with uniform composition free of impurities for advanced research and production purposes.

With a portfolio of products targeting the needs of almost all Nanotechnology work groups, we help our customers by delivering best products with the assurance of quality.

We provide our customers with:
- **High quality nanoparticles, nanopowders and nanowires.**
- **Volume pricing.**
- **Reliable service and prices.**
- **Technical assistance.**

Our products include:
- **Carbon Nanoparticles, Nanotubes, and Fullerenes.**
- **Metal oxides nanoparticles and nanopowders.**
- **Nitrides, Carbides, Arsenides, Antimonides, Borides and Carbonates nanoparticles and nanopowders.**
- **Nanopowder mixtures of various compounds.**
- **Metal nanoparticles, nanopowders and nanowires.**
- **Quantum dots CdTe, CdSe/ZnS (core/shell), ZnCdSe/ZnS (core/shell), CdSe, ZnO.**
- **Graphenes on transparent mica and other substrates.**

Some Applications: Micro and Nano electronics, Sensors and Actuators, Energy (storage and productions), Optical devices, Biomedical and Bionic, Drug delivery, Tissue Engineering Composite Materials, Abrasives, Catalysis and Photocatalysis, Magnetic Materials, Electromagnetic Shielding, Conductive Paints, Photonic Materials, Plasmonics..

DISTRIBUTOR

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carbon allotropes

APPLICATIONS
- FIELD EMISSION
- CONDUCTIVES PLASTICS
- ENERGY STORAGE
- ADHESIVES & CONECTORS
- MOLECULAR ELECTRONICS
- STRUCTURAL COMPOSITES
- FIBRES AND FABRICS
- CATALYST SUPPORTS
- BIOMEDICALS

Carbon (C) is the 6th most abundant element found in the universe, and it has a variety of uses in our everyday lives. It can be found in group 14 of the Periodic Table, and the atomic number of carbon is 6. Carbon has electronic configuration [He]2s22p2, and main formal oxidation state +4 (there are other oxidation states, but all use all of carbon's valence electrons in bonding).
Alongside the central role of Carbon in Organic Chemistry, it forms numerous compounds, both inorganic and organometallic.

There are two main isotopes, with relative abundances: 12C (98.9%, I=0), and 13C (1.1%, I=0.5). I is the nuclear spin, and the half-integer value of the nuclear spin for 13C gives it its usefulness in structure determination by NMR.

Carbon is one of the most stable elements known to man. Elemental carbon occurs in several different forms, ie. it displays a complex allotropy. The primary source of carbon in today's world is the deposits of coal that are mined.

There are 3 allotropes of carbon that are found naturally - graphite, diamonds, and amorphous carbon. The quality that highlights its many uses is that, **this element can combine with almost any other element and form a variety of useful compounds**. The main forms are diamond and graphite, and they exhibit markedly different properties due to the very different structures they adopt.

Diamond and Graphite comparison

- Diamond is **hardest mineral** known to man (10 on Mohs scale), but graphite is one of the softest (1- 2 on Mohs scale).
- Diamond is the ultimate **abrasive**, but graphite is a very **good lubricant**.
- Diamond is an **excellent electrical insulator**, but graphite is a **conductor of electricity**.
- Diamond is usually **transparent**, but graphite is **opaque**.
- Diamond **crystallizes in the isometric system** but graphite **crystallizes in the hexagonal system**.

Carbon Common Uses

In its elemental form, carbon may **have limited uses**. But this element has the ability to manifest itself into a very useful substance for a number of things once it combines with other elements.

Here are some of the commonly found uses of this element.

- Used as a **base for the ink** that is used in inkjet printers.
- Used in the **rims of automobiles** as a black fume pigment.
- Vegetable carbon or activated carbon, is sometimes used as a **bleaching agent, or a gas absorbent**. It is also widely used in filtration systems.
- Carbon (in the form of carbon dioxide), is also used in **fizzy drinks**, **fire extinguishers**, and also as **dry ice** when it is in a solid state.
- In metallurgy, carbon monoxide is used as a **reduction agent** in order to derive other elements and compounds.
- Carbon in the form of 'Freon', is used in **cooling devices and systems**.
- Many **metal cutters**, and heat-resistant tools and devices **are also manufactured with carbon**.
- One of the most abundantly used materials on Earth, **plastic, is produced from synthetic carbon polymers**.

carbon allotropes

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Carbon is as important for nanotechnology as silicon is for electronics, and certainly carbon nanomaterials recently become available for applications are of special interests. Among these **fullerenes, nano-graphite, carbon nanotubes and nano-diamonds**, which are characterized by different proportion of the graphite-like (sp2), diamond-like (sp3) bonds and mixed sp2/sp3 atom bonding are the most studied and found already the most technological applications.

Carbon nanotubes, whiskers, and nanofibers are not only excellent tools for studying 1D phenomena, but they are also among the most important and promising nanomaterials and nanostructures. Carbon nanotubes are already used for insulation and reinforcement of composites, and many materials and structures incorporating nanotubes are yet under development. Extensions to conical and rod-like or wire-like structures provide the scope for new discoveries and novel applications. We may find ourselves in the carbon age within less than a decade.

EMFUTUR technologies welcome this by offering a range of **Carbon allotropes Nanomaterials**

Free web resources
www.nanogloss.com
www.azonano.com
www.nanotech-now.com
www.nanowerk.com

Books
Handbook of Carbon, Graphite, Diamond and Fullerenes - Properties, Processing and Applications
Edited by: Hugh O. Pierson
Publisher: William Andrew Publishing/Noyes Copyright / Pub. Date: © 1993 ISBN: 978-0-8155-1339-1
Electronic
ISBN: 978-0-8155-1739-9 No. Pages: 399

Carbon Nanotechnology
Recent Developments in Chemistry, Physics, Materials Science and Device Applications
Edited by Liming Dai / Copyright © 2006 Elsevier B.V.
ISBN: 978-0-444-51855-2

Some Journal papers
The era of carbon allotropes
Andreas Hirsch / **Nature Materials** 9, 868–871 (2010)
doi:10.1038/nmat2885

Magnetism of the carbon allotropes
R. C. Haddon / Nature 378, 249 - 255 (1995);
doi:10.1038/378249a0

SCIENCE AND TECHNOLOGY OF THE TWENTY-FIRST CENTURY: Synthesis, Properties,and Applications of Carbon Nanotubes
Mauricio Terrones / Annu. Rev. Mater.Res. 2003. 33:419–501
doi: 10.1146/annurev.matsci.33.012802.100255

Chemical synthesis and materials applications of carbon and carbon-related materials special issue of Macromolecular Chemistry and Physics,
guest-edited Klaus Müllen and Markus Antonietti
http://onlinelibrary.wiley.com/doi/10.1002/macp.v213.10/11/issuetoc

EMFUTUR technologies

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Carbon nanotubes

The distinctiveness of the nanotube arises from its structure and the inherent refinement in the structure, which is the helicity in the arrangement of the carbon atoms in hexagonal arrays on their surface honeycomb lattices. The helicity (local symmetry), along with the diameter (which determines the size of the repeating structural unit) introduces significant changes in the electronic density of states, and hence **provides a unique electronic character for the nanotubes**.

These novel electronic properties **create opportunity for development of a range of fascinating electronic device applications**. The other factor of importance in what determines the uniqueness in physical properties is topology, or the closed nature of individual nanotube shells; when individual layers are closed on to themselves certain aspects of the anisotropic properties of graphite disappear, **making the structure remarkably different from graphite**.

The combination of size, structure and topology endows nanotubes with important **mechanical properties** (e.g., high stability, strength and stiffness, combined with low density and elastic deformability) and with **special surface properties** (selectivity, surface chemistry), nanotubes, for the first time represent the ideal, most perfect and ordered, carbon fiber, the structure of which is entirely known at the atomic level. It is this predictability that mainly distinguishes nanotubes from other carbon fibers and puts them along with molecular fullerene species in a special category of prototype materials.

Among the nanotubes, **two varieties**, which differ in the arrangement of their graphene cylinders, share the limelight. **Multi-Walled NanoTubes (MWNT)**, are collections of several concentric graphe-ne cylinders and are larger structures compared to **Single-Walled NanoTubes (SWNTs)** which are individual cylinders of 1–2 nm diameter. The former can be considered as a mesoscale graphite system, whereas the latter is truly a single large molecule. However, SWNTs also show a strong tendency to bundle up into ropes, consisting of aggregates of several tens of individual tubes organized into a one-dimensional triangular lattice. One point to note is that in most applications, although the individual nanotubes should have the most appealing properties, one has to deal with the behavior of the aggregates (MWNT or SWNT ropes), as produced in actual samples.

Owing to their electronic, mechanical, optical, and chemical characteristics, carbon nanotubes attract a good deal of attention from physicists, chemists, biologists, and scientists from other fields. Possible applications in the fields of molecular electronics, nanomechanic devices, information display, sensors, energy storage, and composite materials are of interest for industry. Since their discovery in 1991, several demonstrations have suggested potential applications of nanotubes. These include the use of nanotubes as electron field emitters for vacuum microelectronic devices, individual MWNTs and SWNTs attached to the end of an Atomic Force Microscope (AFM) tip for use as nanoprobe, MWNTs as efficient supports in heterogeneous catalysis and as microelectrodes in electrochemical reactions, and SWNTs as good media for lithium and hydrogen storage. The lack of availability of bulk amounts of well-defined samples and the lack of knowledge about organizing and manipulating objects such as nanotubes (due to their sub-micron sizes) have hindered progress in developing applications. The last few years, however, have seen important breakthroughs that have resulted in the availability of nearly uniform bulk samples. There still remains a strong need for better control in purifying and manipulating nanotubes, especially through generalized approaches.

Products: MWCNT, SWCNT, Industrial CNT, MWCNT Dispersed

APPLICATIONS

- REFRACTORY MATERIALS
- CHEMICAL INDUSTRY
- ELECTRICAL APPLICATIONS
- METALLURGY
- COATINGS
- LUBRICANTS
- PAINT PRODUCTION
- GRINDING WHEELS
- AEROSPACE APPLICATIONS

When you write with a pencil, the marking is created by these sheets sliding off and settling onto the paper. Graphite has been used since the 15th century, but today the applications of graphite have far surpassed use as a writing tool. Graphite is made of extremely strong fibers composed of series of stacked parallel layer sheets. Graphite is black and lustrous, optically opaque, unaffected by weathering, with a pronounced softness graded lower than talc.
Its greasy friction-resistant properties allow for applications in lubricating oils and greases, dry-film lubricants, batteries, conductive coatings, electrical brushes, carbon additives and paints.

Graphite represents a typical layered polymeric crystal and each fullerene can be considered as a molecule which can form molecular crystals (fullerites).

In graphite each carbon atom is covalently bonded to three carbon atoms to give trigonal geometry. Bond angle in graphite is 120oC. Each carbon atom in graphite is sp2 hybridized. Three out of four valence electrons of each carbon atom are used in bond formation with three other carbon atoms while the fourth electron is free to move in the structure of graphite.

Basic trigonal units unite together to give basic hexagonal ring. In hexagonal ring C-C bond length is 1.42 Angstrom. In graphite these rings form flat layers. These layers are arranged in parallel, one above the other. These layers are 3.35 Angstrom apart and are held together by weak van der Waals forces only. These layers can slide over one another. Thus it is very soft. Fourth electron of each carbon atom forms delocalized p-bonds which spread uniformly over all carbon atoms. Due to this reason graphite conducts electricity in the direction parallel to its planes.

Products:

- Graphene nanoplatelets
- Graphene ink
- Graphene oxide
- Graphene films

EM quantum dots

In the large family of nanomaterials, the 0D materials are important building blocks of novel artificial materials with huge technologic impact in an broaden number of area of applications. 0D materials are tiny parts of the matter with size in nanometer scale in all three space directions. Atom clusters and clusters of atomic clusters can be considered zero-dimensional nanostructures.

APPLICATIONS

- COLORS IN STAINED GLASSES
- COMPOSITES
- LASER DIIODES
- LED'S
- OPTICAL DEVICES
- ABSORBER MIRRORS
- PHOTOVOLTAICS
- NANOPHOTONICS
- BIOLOGICAL LABELS
- PHOTODETECTORS

The importance of the nanometer scale comes from the fact that in this range of dimensions the materials properties change significantly from those at larger scales. This is the size scale where so-called quantum effects rule the behavior and properties of particles. Properties of materials are size-dependent in this scale range. When particle size is made to be nanoscale, properties such as melting point, fluorescence, electrical conductivity, magnetic permeability, and chemical reactivity change as a function of the size of the particle..

Quantum Dots are 0D structures confining charge carriers in three dimensions. The carrier confinement is a quantum effect. It totally changes the density of states for the confined particles, compared with the density of states for particles in a larger piece of the material. For an ideal isolated Quantum Dot, there are discrete energy levels, corresponding to a delta-shaped density of states with no states in between the delta peaks. This behavior is known from atoms; in this sense, Quantum Dots can be considered as a kind of artificial atoms where the energy levels can be adjusted by design. There are two ways to do that: by controlling the quantum dot dimensions or the material composition. In reality, large ensembles of quantum dots are normally used, and their size distribution leads to a broadening of density of states distribution, i.e. to inhomogeneous broadening.

Quantum Dots can be fabricated from certain semiconductors. They have an extremely narrow emission spectrum that is directly connected with the particles size. The smaller the particle the more its emission is blue shifted and conversely the larger the particle size, the more its emission is red shifted, thus allowing for the emission of the complete visible light spectra from the same material.

Quantum dots are useful for a large number of applications:

• The oldest application of quantum dots is the achievement of beautiful colors in stained glasses.
• Quantum dots have found applications in composites.
• Quantum dots make possible the fabrication of laser diodes with very low threshold pump power and/or low temperature sensitivity.
• Quantum dots can be used in white light-emitting diodes (LEDs): they are excited with a blue or near-ultraviolet LED and emit e.g. red and green light (acting as a kind of phosphor), so that overall a white color tone is achieved.

Free web sources:
http://www.sciencedaily.com/releases/2012/05/120508173349.htm
http://ce.sysu.edu.cn/mzw/Publications/p2011/15664.html
http://www.materialstoday.com/search/default.aspx?query=quantum%20dots
http://decodedscience.com/novel-developments-for-semiconductor-quantum-dots/2969
http://www.technologyreview.com/news/422857/the-first-full-color-display-with-quantum-dots/

EM nanowires

APPLICATIONS

- MICROELECTRONICS
- SOLAR CELLS
- COMPOSITES
- SENSORS
- OPTICAL DEVICES
- FERROMAGNETIC
- CELL MANIPULATION
- NANOPHOTONICS
- ANTIFUNGAL
- FLEXIBLE DEVICES

Among the nanomaterials, particularly the 1D-materials are highly desirable, as their geometric shape and high surface area impart high functionally. Nanowires are considered as building blocks for the next generation of electronics, photonics, sensors and energy applications.

One-dimensional nanostructures offer unique opportunities to control the density of states of semiconductors, and in turn their electronic and optical properties. Nanowires allow the growth of axial heterostructures without the constraints of lattice mismatch. This provides flexibility to create heterostructures of a broad range of materials and allows integration of compound semiconductor based optoelectronic devices with silicon based microelectronics.

For example, metal nanowires are likely to become an integral part of future nanodevices, at least as the elements interconnecting the functional components such as nano-transistors.

Additional to the provision of electrical connection to nano-circuits, the metal nanowires are expected to be utilized as the functional components in various applications ranging from high density perpendicular data storage to nano-sensors, from high-sensitivity nano-electrodes to metamaterials, and so on.

Nanowires are widely studied and the number of papers published in the field is growing exponentially with time. Already nanowire lasers, nanowire transistors, nanowire light emitting diodes, nanowire sensors and nanowire solar cells have been demonstrated.

EMFUTUR Technologies anticipate the market needs in this innovative direction providing high quality NANOWIRES

Some free web references:

http://www.intechopen.com/subjects/nanotechnology-and-nanomaterials/books/all

http://www.intechopen.com/books/nanowires-implementations-and-applications

http://pubs.rsc.org/en/content/ebook/978-1-84973-058-7

Products: Cobalt, Nickel, Silver, ..

Beyond the future

carbon allotropes

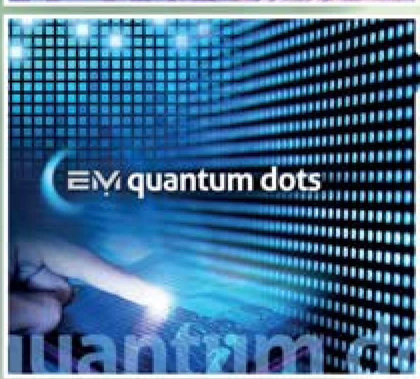
Carbon Nanotubes (Multiwalled, Single Walled, Double, Short,..)
Fullerenes C60, C70, ..
Graphite
Graphene nanoplatelets
Monolayer graphene layer
Graphene oxide
Reduced graphene oxide
Carbon Black

APPLICATIONS
Field Emission
Conductive plastics
Energy storage
Thermal materials
Fibers and Fabrics
Biomedical
Orthopedic prostheses
Refractory materials
Lubricants
Aerospace applications

nanowires

Cobalt
Nickel
Copper
Silver
Titanium
Aluminum
Gold
Lead Zirconate Titanate
Lead Titanate
Manganese Oxide / Vanadium Oxide / Tungsten Oxide

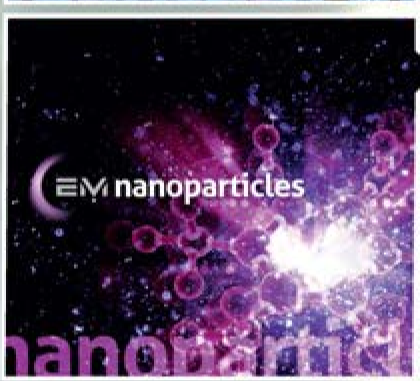
APPLICATIONS
Microelectronics
Solar Cells
Composites
Sensors
Optical devices
Ferromagnetic
Catalysis
Cell manipulation
Antifungal
Flexible devices



quantum dots

CdTe
CdSe/ZnS
ZnCdSeS
ZnO
ZnCuInS/ZnS
ZnCdSe/ZnS

APPLICATIONS
Colors in stained glasses
Composites
Laser diodes
Led's
Optical devices
Absorber Mirrors
Photovoltaics



nanoparticles

Carbides
Metal Nanoparticles
Metal oxide nanoparticles
Nanoblends
Nitrides
Silicon Nanoparticles
Titanium Boride
Titanium Carbonitride
Gallium Antimonide / Arsenide

APPLICATIONS
Colors in stained glasses
Composites
Laser diodes
Led's
Optical devices
Absorber Mirrors
Photovoltaics

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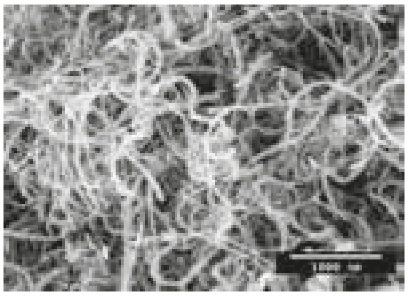
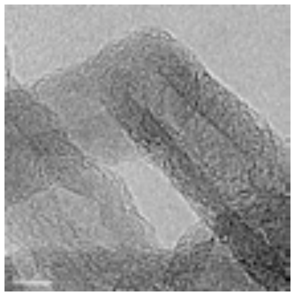
EMFUTUR technologies

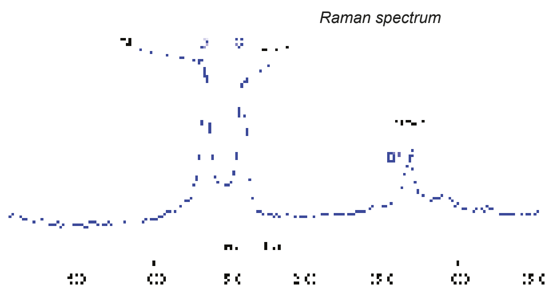

PRICELIST
EMFUTUR
technologies

Carbon Nanotubes, multiwalled

Carbon purity: min. 95%
Number of walls: 3-15
Outer diameter: 5-20 nm; Inner diameter: 2-6 nm; Length: 1-10 µm
Apparent density: 0,15-0,35 g/cm^3; Loose agglomerate size: 0,1-3 mm
Specific surface: ca. 240 m^2/g







EM-MCNP-1g	1 g	36,00 EUR
EM-MCNP-10g	10 g	80,00 EUR
EM-MCNP-50g	50 g	256,00 EUR
EM-MCNP-100g	100 g	399,00 EUR

Carbon Nanotubes, multiwalled, charged, water soluble up to 30 µg/ml

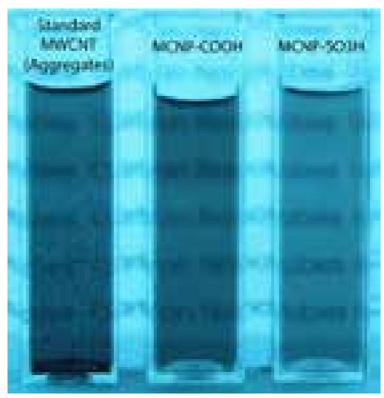
Carbon nanotubes (CNTs) type EM-MCNP , additionally modified by - COOH or -SO3H groups. Soluble in water forming dark, transp . suspensions stable for many months. Image: aq . suspensions of unstable unmodified (left) and stable modified CNT s.

COOH- modified:

EM-MCNP-COOH-100mg	100 mg	69,00EUR
EM-MCNP-COOH-500mg	500 mg	225,00 EUR
EM-MCNP-COOH-1g	1 g	325,00 EUR

SO_3H- modified:

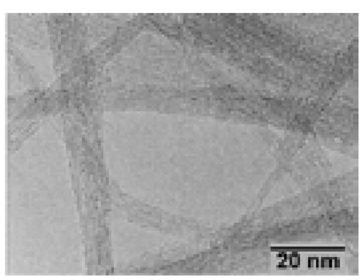
EM-MCNP -SO3H-100mg	100 mg	69,00 EUR
EM-MCNP-SO3H-500mg	500 mg	225,00 EUR
EM-MCNP-SO3H-1g	1 g	325,00 EUR

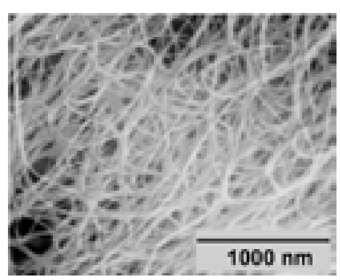


Carbon Nanotubes, single-walled

Produced by arc discharge method. SWCNTs assembled in bundles
Carbon purity: > 85%; Nanotube purity: > 74%; Diameter: ca. 1,5 nm

EM-SCNP-M-100mg	100 mg	115,00 EUR
EM-SCNP-M-500mg	500 mg	415,00 EUR





NanoWires

Metallic nanowires of different elements have been synthesized. Besides of those present in this catalogue, Emfutur can perform custom synthesis of other nanowires like Au, Ni-Co and Ni-Fe of various compositions etc.

Cobalt Nanowires

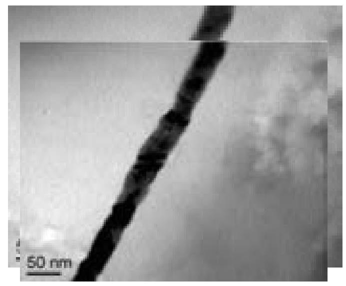
Average diameter: 200-300 nm
Length: up to 200 µm

EM-CoW200-10mg	10 mg	49,00 EUR
EM-CoW200-100mg	100 mg	235,00 EUR
EM-CoW200-1g	1 g	445,00 EUR

Copper Nanowires

Average diameter: 40-50 nm
Length: up to 50 µm

EM-CuW50-10mg	10 mg	39,00 EUR
EM-CuW50-50mg	50 mg	99,00 EUR
EM-CuW50-200mg	200 mg	319,00 EUR



Lead Nanowires

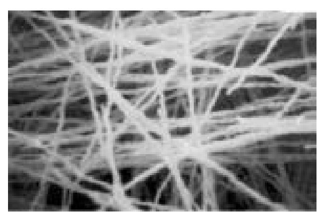
Average diameter: 80±20 nm
Length: up to several millimetres. Superconductor at 4K

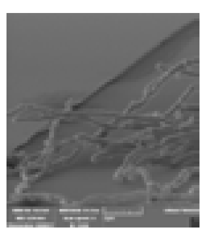
EM-PbW100-10mg	10 mg	39,00 EUR
EM-PbW100-50mg	50 mg	99,00 EUR
EM-PbW100-200mg	200 mg	319,00 EUR

Nickel Nanowires

Average diameter: 200-300 nm
Length: up to 200 µm

EM-NiW200-10mg	10 mg	49,00 EUR
EM-NiW200-100mg	100 mg	235,00 EUR
EM-NiW200-1g	1 g	445,00 EUR



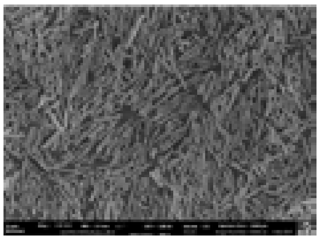


Silver Nanowires

EM-AgW50-10mg	Average diameter 50 nm Length: 5-50 µm	10 mg	49,00 EUR
EM-AgW50-50mg		50 mg	145,00 EUR
EM-AgW100-10mg	Average diameter 100 nm Length: 5-50 µm	10 mg	49,00 EUR
EM-AgW100-50mg		50 mg	99,00 EUR
EM-AgW200-10mg	Average diameter 200 nm Length: 5-50 µm	10 mg	49,00 EUR
EM-AgW200-50mg		50 mg	99,00 EUR

ZnO Nanowires

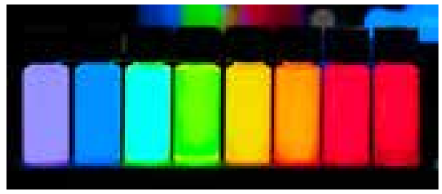
Length full range: 0,2-7 µm
Average diameter: 50-80 nm
Dry powder
*available as hydrophobic NWs too

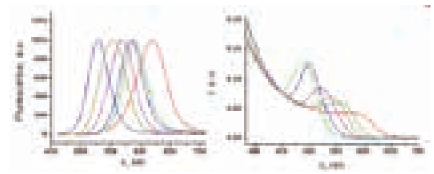


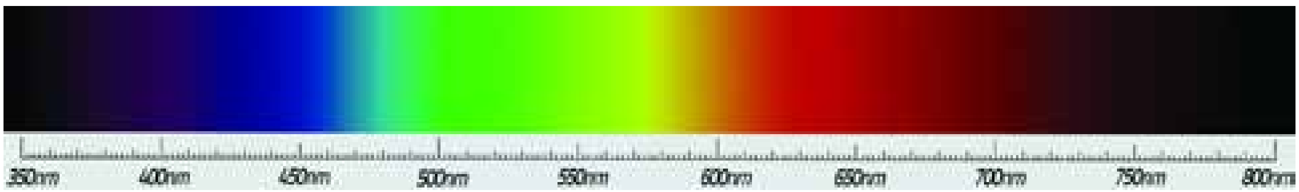
EM-ZnOW50-100mg	100 mg	59,00 EUR
EM-ZnOW50-500mg	500 mg	229,00 EUR
EM-ZnOW50-1g	1 g	299,00 EUR

Quantum Dots

Luminescent inorganic nanocrystals (Q-dots). The emis-sion wavelength is a function of the crystal size or struc-ture - crystals of the same chemistry can have the emis-sion maxima in a wide range.
Hydrophilic Q-dots are coated with -COOH groups and can be easily used for labeling purposes for chemical and biological applications.
CdSe/ZnS, ZnCdSe/ZnS, ZnCuInS/ZnS (core/shell type), and perovskite Q-dots are available as **hydro-phobic** and **hydrophilic** modifications.
Q-dots can be supplied up to kilogram quantities.







CdTe Quantum Dots, hydrophilic

Easily forms colloidal solutions in water. Terminated with -COOH group. Supplied as a powder readily soluble in water. Ideal for labeling purposes. Coupling with -NH_2 groups can be achieved through EDC-mediated esterefication.

General labeling procedure for proteins
(adopted from Wang et al. Nanoletters 2002, vol. 2, No. 8, 817-822):
Reaction mixture containing 0,1 µM/mL CdTe quantum dots, 2 mg/mL protein, 1 mg/mL sulfo-NHS (CAS# 106627-54-7), 10 mg/mL EDC (CAS# 25952-53-8) in pH 7,0 PBS buffer is prepared and stored for 2-4 h at room temperature and then stored at 4°C overnight.
The precipitate (unconjugated Q-dots) if any is removed by centrifugation. The stock of ready-to-use product should be stored at 4°C. Optionally it can be dialyzed on a memb-rane with MWCO of 12000-14000 against pH 7,0 PBS buffer and stored at 4°C. Emission wavelength may slightly shift after labeling procedure.

510, 520, 530, 540, 550, 560, 570, 580, 590 600, 610, 620, 630, 640, 650, 660, 670, 680, 690, 700, 710, 720, 730, 740, 750, 760, 770, 780 , 790 ± 5 nm λ emission maximum

Catalogue Number	Quantity	Price
EM-QDN-5mg	5 mg	52,00 EUR
EM-QDN-10mg	10 mg	99,00 EUR
EM-QDN-25mg	25 mg	195,00 EUR
EM-QDN-50mg	50 mg	349,00 EUR

Zn-Cu-In-S/ZnS Quantum Dots, cadmium free, hydrophilic

Non-toxic luminescent Zn-Cu-In-S / ZnS (core / shell) quantum dots coated with hydrophilic organic ligands. Readily soluble in water. Emission peak width (FWHM) ca. 100 nm. Large Stokes shift (ca. 120 nm). Particle size: 4-5 nm. Supplied as a readily soluble powder.

530 , 560, 590, 610, 650, 700 ± 15 nm λ emission maximum

EM-QD-WCF-25mg	25 mg	139,00 EUR
EM-QD-WCF-100mg	100 mg	400,00 EUR
EM-QD-WCF-250mg	250 mg	885,00 EUR

Zn-Cu-In-S/ZnS Quantum Dots, cadmium free, hydrophobic

Non-toxic luminescent Zn-Cu-In-S / ZnS (core / shell) quantum dots coated with hydrophobic organic ligands. Readily soluble in toluene, chloroform and similar sol-vents. Not soluble in water, alcohols, ethers. Emission peak width (FWHM) ca. 100 nm. Large Stokes shift (ca. 120 nm). Particle size: 4-5 nm. Supplied as a readily soluble powder

530, 560, 590, 610, 650, 700 ± 15 nm λ emission maximum

EM-QD-CF-25mg	25 mg	239,00 EUR
EM-QD-CF-100mg	100 mg	660,00 EUR
EM-QD-CF-250mg	250 mg	1395,00 EUR

ZnCdSeS Quantum Dots, low-Cd, hydrophilic, QD-WA

Alloyed QDs are the newest generation of low-cadmium, highly luminescent semi-conductor nanocrystals. Coated with hydrophilic organic ligands. Readily soluble in water. Diameter ca. 6 nm. Supplied as a readily soluble powder.

470,480,490,500,510,520,530,540,550,560,570,580,590,600,610,620,630 ± 5 nm λ emission maximum

EM-QD-WA-10mg	10 mg	119,00 EUR
EM-QD-WA-25mg	25 mg	199,00 EUR
EM-QD-WA-100mg	100 mg	630,00 EUR

ZnCdSeS Quantum Dots, low-Cd, hydrophobic

Alloyed QDs are the newest generation of low-cadmium, highly luminescent semi-conductor nanocrystals with **improved stability** and compatibility with composites. Coated with hydrophobic organic molecules. Readily soluble in hexane, heptane, toluene, chloroform, tetrahydrofuran, pyridine. Diameter ca. 6 nm. Supplied dry.

470, 480, 490, 500, 510, 520, 530, 540, 550, 560, 570, 580, 590, 600, 610, 620, 630 ± 5 nm λ emission maximum

EM-QD-OA-10mg	10 mg	89,00 EUR
EM-QD-OA-25mg	25 mg	169,00 EUR
EM-QD-OA-100mg	100 mg	505,00 EUR

ZnCdSe/ZnS (core/shell) Quantum Dots, dry, hydrophobic

Highly luminescent semiconductor nanocrystals coated with hydrophobic orga-nic molecules. Readily soluble in toluene, chloroform, tetrahydrofuran, pyridine etc. Not soluble in water, alcohols, ethers.

440 , 480 ± 5 nm λ emission maximum.

EM-QD-OS-5mg	5 mg	69,00 EUR
EM-QD-OS-10mg	10 mg	119,00 EUR
EM-QD-OS-25mg	25 mg	219,00 EUR

CdSe/ZnS (core/shell) Quantum Dots, dry, hydrophobic

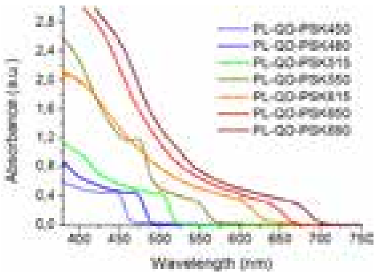
Highly luminescent semiconductor nanocrystals coated with hydrophobic organic molecules. Readily soluble in toluene, chloroform, tetrahydrofuran, pyridine etc. Not soluble in water, alcohols, ethers. ZnS shell thickness - ca. 0,6 nm.

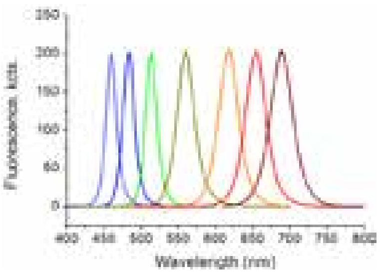
530,540,550,560,570, 580, 590, 600, 610,620,630,640,650 ± 5 nm λ emission maximum.

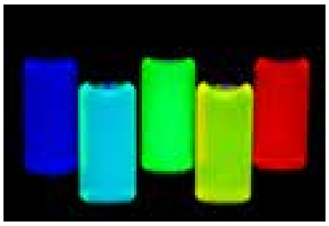
EM-QD-O-5mg	5 mg	65,00 EUR
EM-QD-O-10mg	10 mg	99,00 EUR
EM-QD-O-25mg	25 mg	190,00 EUR

Perovskite Quantum Dots, cadmium free, hydrophobic

Cd-free strongly luminescent perovskite quantum dots of structure ABC_3 coated with hydrophobic organic ligands. Readily soluble in toluene, hexane, chloroben-zene and similar dry solvents. Not soluble in alcohols, ethers and other polar solvents. Avoid using water or water-containing solvents. Emission peak width (FWHM) ca. 15-35 nm. Particle size: ca. 10 nm.
Ideal for **industrial applications** due to the large scale manufacturing, and the **lowest prices among all available QDs**. For bulk quantities, please contact us at mail@emfutur.com







450, 480, 510, 530, 550 ± 15 nm λ emission maximum.

EM-QD-PSK-5mg	5 mg	42,00 EUR
EM-QD-PSK-50mg	50 mg	159,00 EUR
EM-QD-PSK-500mg	100 mg	420,00 EUR

Quantum Dots Kits - hydrophilic

Get quantum dots of different colours at a reduced price.

Hydrophilic CdTe Quantum Dots Kit

One kit of five types of quantum dots, 5 mg, 10 mg or 50 mg each type:
Supplied as dry powder. Soluble in water.

Green - $\lambda_{emission\ max}$ 510-550 nm
Yellow - $\lambda_{emission\ max}$ 560-580 nm
Orange - $\lambda_{emission\ max}$ 590-620 nm
Red - $\lambda_{emission\ max}$ 630-650 nm
Ruby - $\lambda_{emission\ max}$ 660-700 nm

EM-QDN-Kit5	5 x 5 mg	185,00 EUR
EM-QDN-Kit10	5 x 10 mg	265,00 EUR
EM-QDN-Kit50	5 x 50 mg	999,00 EUR

Hydrophilic Zn-Cu-In-S/ZnS Cd-free Quantum Dot Kit

One kit of four types of quantum dots, 10 mg, 25 mg or 100 mg each type:
Supplied as dry powder. Soluble in water.

Green - $\lambda_{em.}$ 530 ± 20 nm
Yellow - $\lambda_{em.}$ 570 ± 20 nm
Orange - $\lambda_{em.}$ 610 ± 20 nm
Ruby - $\lambda_{em.}$ 670 ± 30 nm

EM-QD-WCF-Kit10	4 x 10 mg	220,00 EUR
EM-QD-WCF-Kit25	4 x 25 mg	685,00 EUR
EM-QD-WCF-Kit100	4 x 100 mg	975,00 EUR

Hydrophilic, alloyed ZnCdSeS Quantum Dots Kit

One kit of five types of quantum dots, 10 mg, 25 mg or 100 mg each type: Supplied as dry powder. Soluble in water.

Blue - $\lambda_{em.}$ 470-480 nm
Cyan - $\lambda_{em.}$ 490-500 nm
Green - $\lambda_{em.}$ 510-550 nm
Yellow - $\lambda_{em.}$ 560-580 nm
Orange - $\lambda_{em.}$ 590-620 nm

EM-QD-WA-Kit10	5 x 10 mg	290,00 EUR
EM-QD-WA-Kit25	5 x 25 mg	690,00 EUR
EM-QD-WA-Kit100	5 x 100 mg	2145,00 EUR

Quantum Dots Kits - hydrophobic

Get quantum dots of different colours at a reduced price.

Hydrophobic CdSe/ZnS Quantum Dots Kit

One kit of five types of quantum dots, 5 mg, 10 mg or 50 mg each type:
Supplied as dry powder. Soluble in chloroform, toluene etc.

Blue - $\lambda_{emission\ max}$ 450-500 nm
Green - $\lambda_{emission\ max}$ 510-550 nm
Yellow - $\lambda_{emission\ max}$ 560-580 nm
Orange - $\lambda_{emission\ max}$ 590-620 nm
Red - $\lambda_{emission\ max}$ 630-650 nm

EM-QD-O-Kit5	5 x 5 mg	179,00 EUR
EM-QD-O-Kit10	5 x 10 mg	259,00 EUR
EM-QD-O-Kit50	5 x 50 mg	999,00 EUR

Hydrophobic Zn-Cu-In-S/ZnS Cd-free Quantum Dot Kit

One kit of four types of quantum dots, 10 mg, 25 mg or 100 mg each type:
Supplied as dry powder. Soluble in hexane, toluene etc.

Green - $\lambda_{em.}$ 530 ± 20 nm
Yellow - $\lambda_{em.}$ 570 ± 20 nm
Orange - $\lambda_{em.}$ 610 ± 20 nm
Ruby - $\lambda_{em.}$ 670 ± 30 nm

EM-QD-CF-Kit10	4 x 10 mg	179,00 EUR
EM-QD-CF-Kit25	4 x 25 mg	269,00 EUR
EM-QD-CF-Kit100	4 x 100 mg	785,00 EUR

Hydrophobic alloyed ZnCdSeS Quantum Dots Kit

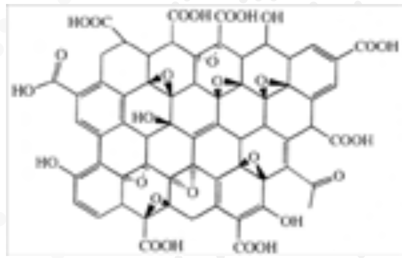
One kit of five types of quantum dots, 10 mg, 25 mg or 100 mg each type:
Supplied as dry powder. Soluble in hexane, toluene etc.

Blue - $\lambda_{em.}$ 470-480 nm
Cyan - $\lambda_{em.}$ 490-500 nm
Green - $\lambda_{em.}$ 510-550 nm
Yellow - $\lambda_{em.}$ 560-580 nm
Orange - $\lambda_{em.}$ 590-620 nm

EM-QD-OA-Kit10	5 x 10 mg	225,00 EUR
EM-QD-OA-Kit25	5 x 25 mg	555,00 EUR
EM-QD-OA-Kit100	5 x 100 mg	1759,00 EUR

Graphene Oxide Water Dispersion
(0.4 wt% Concentration)

250 mL (1 g of GO content)	55 EUR
2500 mL (10 g of GO content)	230 EUR



Product Datasheet

Graphene Oxide (GO)

Properties

Form	Dispersion of graphene oxide sheets
Particle size (SEM)*	< 10µm
Color	Yellow-brown
Odor	Odorless
Dispersibility	Polar solvents
Solvents	Water
Concentration	4 mg/mL
pH	2,2-2,5
Monolayer content (measured in 0.5mg/mL)	>95%**

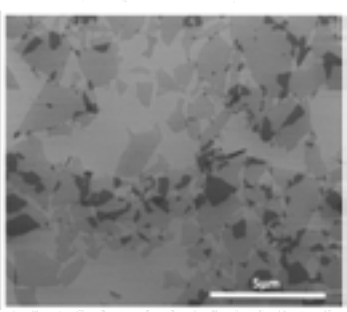
(*) This data was obtained by SEM image analysis.
(**) 4mg/ml concentration tends to agglomerate the GO flakes and dilution followed by slight sonication is required in order to obtain a higher percentage of monolayer flakes.

Elemental Analysis*

Carbon	49-56%
Hydrogen	0-1%
Nitrogen	0-1%
Sulfur	2-4%
Oxygen	41-50%

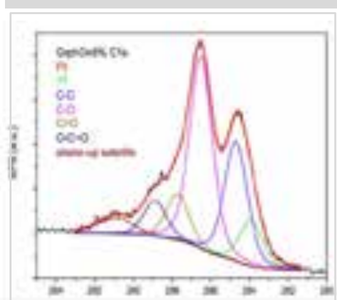
(*) Sample preparation: 2g of 4wt% GO in water were dried under vacuum at 60°C overnight.

SEM image



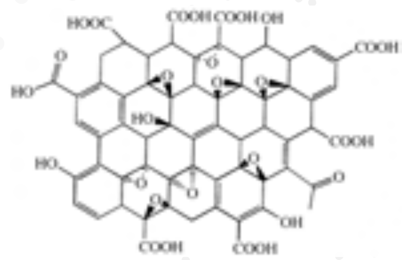
TEM image

XPS



Highly Concentrated Graphene Oxide
(2.5 wt% Concentration)

400 mL (10 g of GO content)	400 EUR
4000 mL (100 g of GO content)	1.300 EUR



Product Datasheet

Graphene Oxide (GO)

Properties

Form	Slurry
Particle size (laser diffraction)*	D90 29-33 µm
	D50 14-17 µm
	D10 6-7 µm
Color	Dark brown
Odor	Odorless
Dispersibility	Polar solvents
Concentration (wt%)	2,5
pH (4mg/mL dispersion)	1,8-2,0

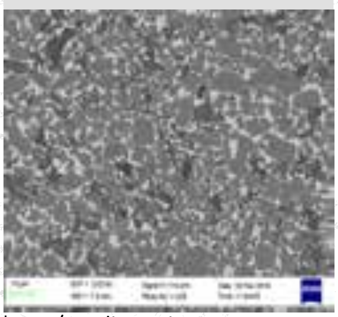
*This data corresponds to the slurry format. Please consider that particle size is reduced with a sonication treatment

Elemental Analysis*

Carbon	49-56%
Hydrogen	0-
Nitrogen	0-
Sulfur	2-
Oxygen	41-

*Sample preparation: 2g of 4wt% GO in water were dried under vacuum at 60°C overnight.

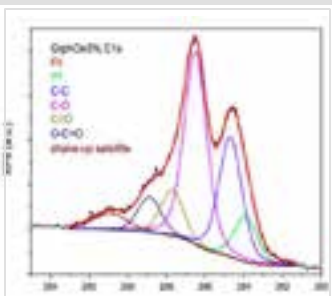
SEM image*



*4mg/mL dispersion

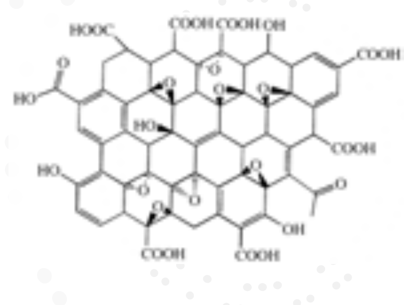
TEM image

XPS



Graphene Oxide Powder
(1 gram)

1 g	50 EUR
5 g	250 EUR



Product Datasheet

Graphene Oxide (GO)

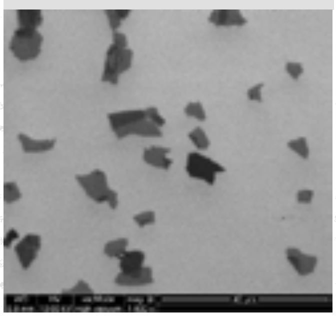
Properties

Form	Powder
Particle size (laser diffraction)	D90 25-28 µm
	D50 13-15 µm
	D10 6-7 µm
Color	Brown
Odor	Odorless
Dispersibility	Polar solvents
Humidity (TGA)	13-

Elemental Analysis

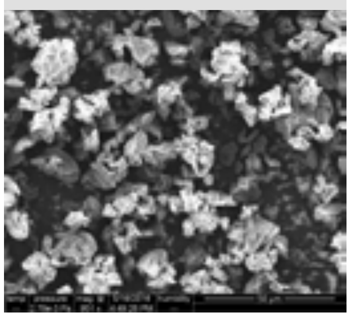
Carbon	49-56%
Hydrogen	0-
Nitrogen	0-
Sulfur	2-
Oxygen	41-

SEM image*



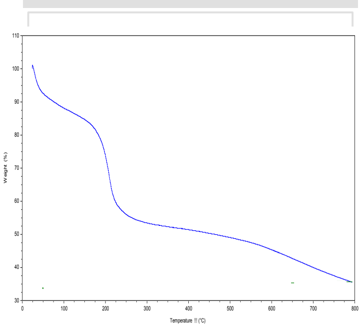
(*) 0.5mg/mL water dispersion

SEM image**



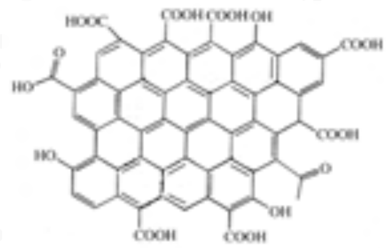
(**) Powder format

TGA



Reduced Graphene Oxide
(1 gram)

1 g	96 EUR
5 g	180 EUR



Product Datasheet
Reduced Graphene Oxide (rGO)

Properties

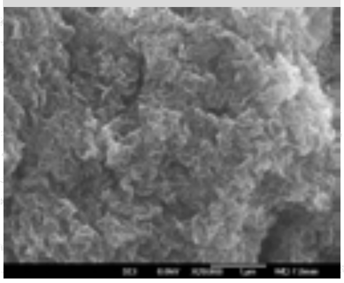
Form	Powder
Particle size (laser diffraction)	D90 10-15µm
	D50 4-6 µm
	D10 1-3 µm
Reduction method	Chemically reduced
Color	Black
Odor	Odorless
Solubility	Insoluble
Dispersability	low concentrations (<0.1mg/mL) in NMP, DMSO, DMF
Humidity (Karl Fisher, TGA)	3.7-4.2%
Electrical conductivity	≈ 667 S/m (*)
BET surface area	423-498 m^2/g
Density	1,91 g/cm^3

(*) Measured in a 20nm thickness film

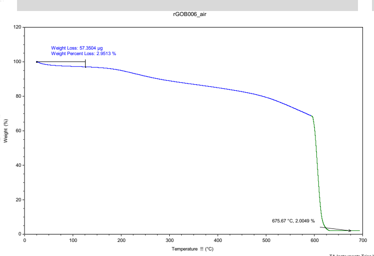
Elemental Analysis

Carbon	77-87%
Hydrogen	0-1%
Nitrogen	0-1%
Sulfur	0%
Oxygen	13-19%

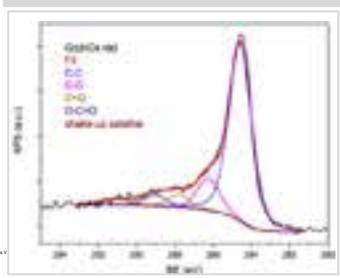
SEM image



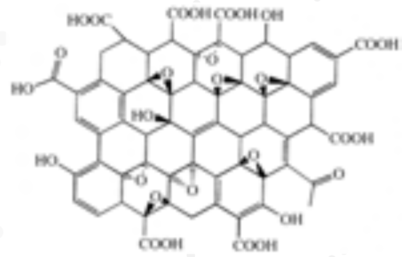
TGA



XPS



Graphene Oxide Film



1 unit	50 EUR
5 units	250 EUR

Product Datasheet
Graphene Oxide (GO) Film

Properties

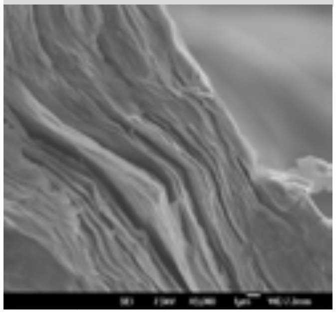
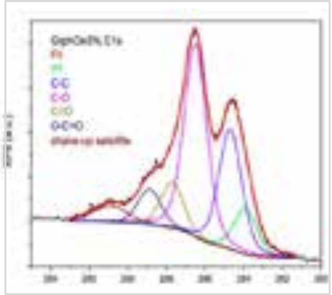
Form	Film
Film diameter	4 cm
Color	Yellow-brown
Odor	Odorless
Dispersibility	Polar solvents
Thickness	10-13 µm
Sheet resistance*	$0.514 \pm 0.236\ M\Omega\ sq^{-1}$

*Measure in a 40microns film

Elemental Analysis*

Carbon	49-56%
Hydrogen	0-1%
Nitrogen	0-1%
Sulfur	0-2%
Oxygen	41-50%

Sample preparation: 2g of 4wt% GO in water were dried under vacuum at 60°C overnight.

SEM image	Macro Picture	XPS
		

Amine Functionalized Graphene Oxide
(1 gram)

1 g	96 EUR
5 g	180 EUR

Product Datasheet

Aminated Graphene Oxide (fGO)

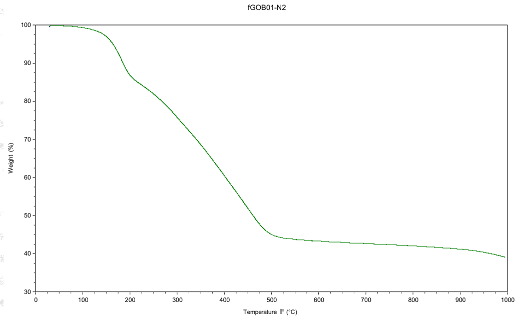
Properties

Form	Powder
Amine	Dodecyl amine
Color	Black
Odor	Odorless
Dispersability	low concentrations (<0.1mg/mL) in NMP, DMSO, DMF
Apparent density (mg/mL)	0,0993
Humidity (TGA)	1-3%

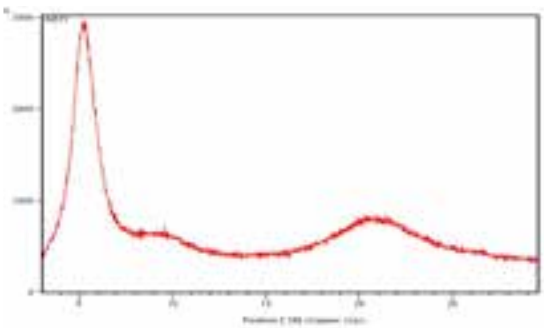
Elemental Analysis

Carbon	65-74%
Hydrogen	6-9%
Nitrogen	2-4%
Sulfur	1-2%
Oxygen	16-22%

TGA



XRD



graphene

EMFUTUR Graphene are high purity, low defect, ultra thin particles of graphite of nanometer scale thickness. They can be thought of as short stacks of graphite sheets made through a proprietary manufacturing process. They are produced in several grades and sizes.

The unique size and platelet morphology of **EMFUTUR Graphene** makes these particles especially effective at providing barrier properties, while pure graphitic composition makes them excellent electrical and thermal conductors. Unlike many other additives,EMFUTUR Graphene can improve mechanical properties such as stiffness, abrasion resistance, and surface hardness of the matrix material.

EMFUTUR Graphene are compatible with almost ali polymers and can be an active ingredient in inks or coatings. The unique non-oxidizing manufacturing processes give the **EMFUTUR Graphene** a pristine graphitic surface of sp2 carbon molecules that makes it especially suitable for applications requiring high electrical or thermal conductivity.

Available as bulk powder or in dispersions::

Bulk powder **or** dispersions:

* **EMFC** * Aqueous
* **EMFH** * IIPAA
* **EMFM** * Organic solvents
* **EMFR** * Resins and custom

Product Characteristics

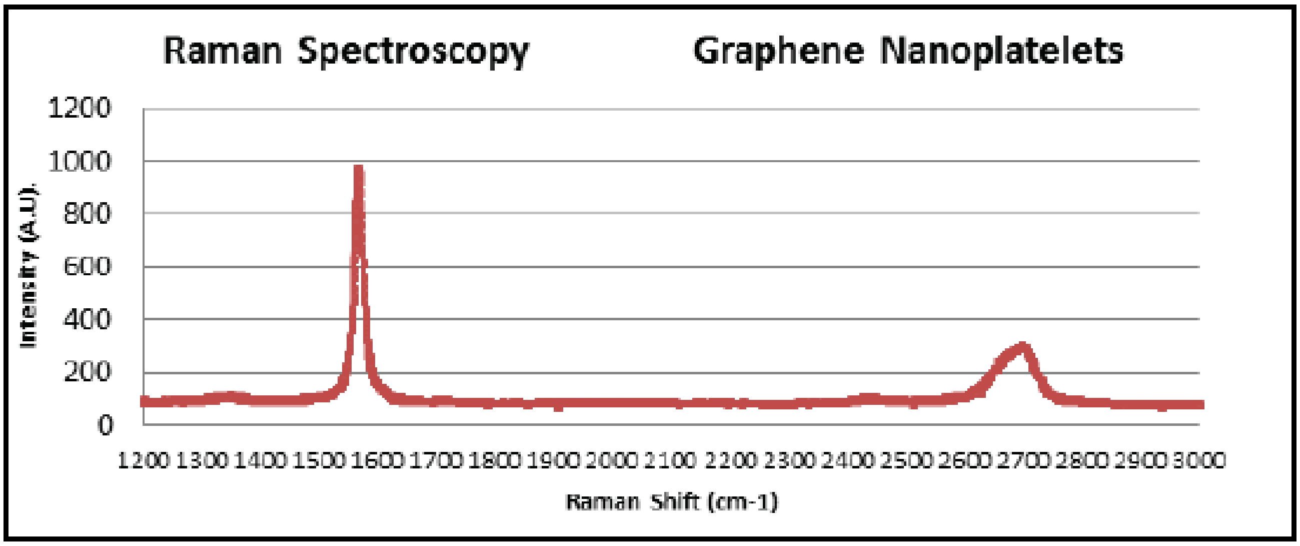
Appearance	Black granules
Bulk Density	0.03 – 0.1 g/cc
Oxygen Content	< 5%
Residual Acid Content	< 0.5 wt%

Potential applications include

- Anode materials for lithium-ion batteries
- Conductive additives for battery electrodes
- Ultracapacitor electrodes
- Electrically conductive inks
- Films and coatings for EMI shielding
- Thermally conductive inks and coatings
- Thermal Interface Materials
- Heat spreaders
- Additive for high-strength, lightweight composites
- Additive for metal-matrix composites
- Substrates for chemical and biochemical sensors
- Barrier coatings for packaging
- Barrier coatings for anti-corrosion
- Additives for concrete
- Additives for lubricants

EMFUTUR Graphene – EMFR

EMFUTUR Graphene are unique nanoparticles consisting of short stacks of graphene sheets having a platelet shape. EMFR particles have a typical surface area of 30 to 60m2/g. EMFR is available with average particle diameters of 7, 10, or 25 microns.



	Parallel To Surface	Perpendicular To Surface
Density (g/c³)	2.2	2.2
LOI – Loss on Ignition (wt %)	≥ 99.0	≥ 99.0
Thermal Conductivity (W/m.K)	3,000	6
Thermal Expansion (m/m/K)	$4 - 6 \times 10^{-6}$	$0.5 - 1.0 \times 10^{-6}$
Tensile Modulus (MPa)	1,000	NA
Tensile Strength (MPa)	5	NA
Electrical Conductivity (S/m)	10^{7}	10^{2}

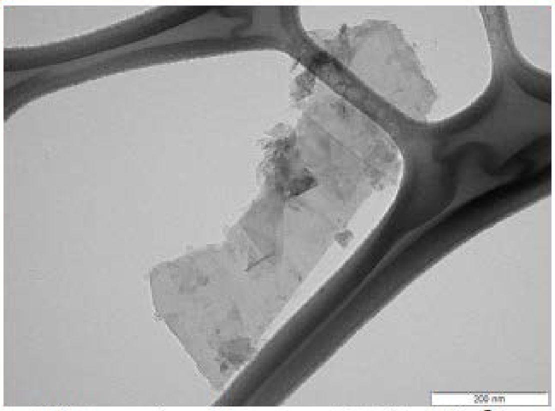
EMFRR

30 to 60 m2/g	7, 10, or 25 microns	100 g	995,00 EUR

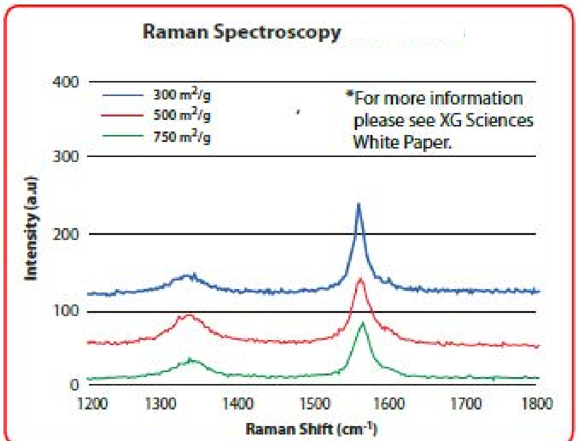
EMFUTUR Graphene – EMFC

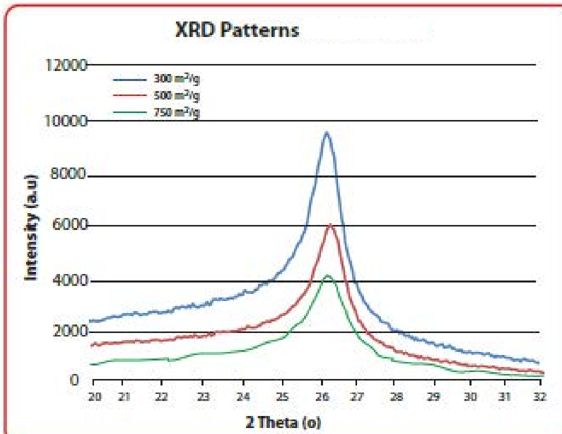
EMFUTUR Graphene are unique nanoparticles consisting of short stacks of graphene sheets having a platelet shape. **EMFC** particles are available in different grades that are designated by their approximate surface area.

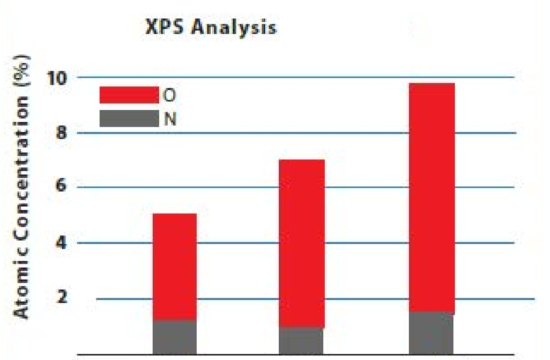
EMFC particles typically consist of aggregates of sub-micron platelets that have a particle diameter of less than 2 microns and a typical particle thickness of a few nanometers, depending on the surface area. Grade C particles can be ordered with average surface areas of ***300, 500, and 750 m^2/g.***



TEM Image of nearly transparent platelet - 750 m^2/g







Characteristics of Bulk Powder

Property	*Typical Value*
Appearance	Black granules/powder
Bulk Density	0.2 to 0.4 g/cc
Relative Gravity	2.0-2.25 g/cc

**Note: nanoplatelets have naturally occurring functional groups like ethers, carboxyls, or hydroxyls that can react with atmospheric humidity to form acids or other compounds. These functional groups are present on the edges of the particles and their wt% varies with particle size.*

EMFC

300, 500, and 750 m2/g	<2 microns	100 g	995,00 EUR

EMFUTUR Graphene – EMFH

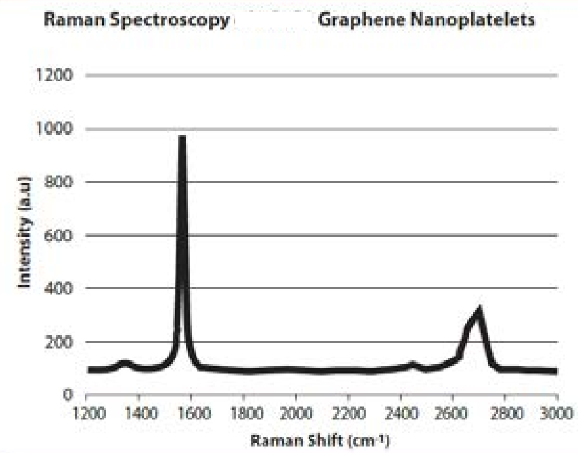
EMFUTUR *Graphene* are unique nanoparticles consisting of short stacks of graphene sheets having a platelet shape. Each grade contains particles with a similar average thickness and surface area.

EMFH particles have an average thickness of approximately *15 nanometers* and a typical surface area of *50 to 80 m^2/g.* Grade H is available with average particle diameters of ***5, 15,*** or ***25*** microns.

Characteristics of Bulk Powder

Property	*Typical Value*
Appearance	Black granules
Bulk Density	0.03 to 0.1 g/cc
Oxygen Content*	< 1 percent
Residual Acid Content*	< 0.5 wt%

**Note: nanoplatelets have naturally occurring functional groups like ethers, carboxyls, or hydroxyls that can react with atmospheric humidity to form acids or other compounds.*



	Parallel To Surface	Perpendicular To Surface
Density (g/c³)	2.2	2.2
LOI – Loss on Ignition (wt %)	≥ 99.0	≥ 99.0
Thermal Conductivity (W/m.K)	3,000	6
Thermal Expansion (m/m/K)	$4 - 6 \times 10^{-6}$	$0.5 - 1.0 \times 10^{-6}$
Tensile Modulus (MPa)	1,000	NA
Tensile Strength (MPa)	5	NA
Electrical Conductivity (S/m)	10^{7}	10^{2}

EMFH

50 to 80 m2/g	5, 15, or 25 microns	100 g	995,00 EUR

EMFUTUR Graphene – EMFM

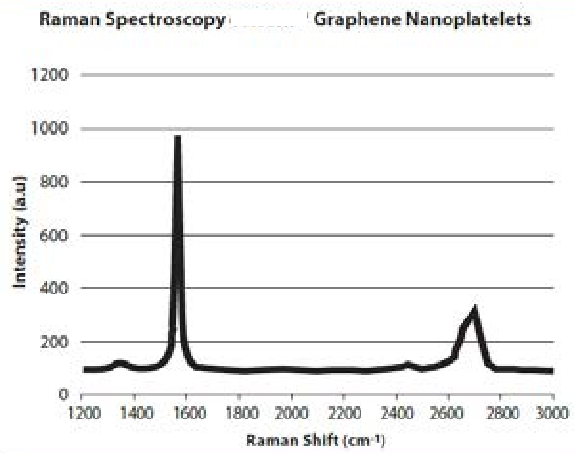
EMFUTUR *Graphene* are unique nanoparticles consisting of short stacks of graphene sheets having a platelet shape. Each grade contains particles with a similar average thickness and surface area.

EMFM particles have an average thickness of approximately *6 to 8 nanometers* and a typical surface area of *120 to 150 m^2/g.* Grade M is available with average particle diameters of ***5, 15,*** or ***25*** microns.

Characteristics of Bulk Powder

Property	*Typical Value*
Appearance	Black granules
Bulk Density	0.03 to 0.1 g/cc
Oxygen Content*	< 1 percent
Residual Acid Content*	< 0.5 wt%

**Note: nanoplatelets have naturally occurring functional groups like ethers, carboxyls, or hydroxyls that can react with atmospheric humidity to form acids or other compounds.*



	Parallel To Surface	Perpendicular To Surface
Density (g/c³)	2.2	2.2
LOI – Loss on Ignition (wt %)	≥ 99.0	≥ 99.0
Thermal Conductivity (W/m.K)	3,000	6
Thermal Expansion (m/m/K)	$4 - 6 \times 10^{-6}$	$0.5 - 1.0 \times 10^{-6}$
Tensile Modulus (MPa)	1,000	NA
Tensile Strength (MPa)	5	NA
Electrical Conductivity (S/m)	10^{7}	10^{2}

EMFM			
120 to 150 m2/g	5, 15, or 25 microns	100 g	995,00 EUR

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