LayerOne
Advanced Materials

Technical Data Sheet
Reduced Graphene Oxide

REGOX™ Graphene P999

REDUCED GRAPHENE OXIDE PREPARATION METHOD

LayerOne Fully Reduced Graphene Oxide (rGO) 99% C is prepared by thermal reduction (flashing) of GO powder.

PHYSICAL PROPERTIES

Materials property	Analytical method	Value / test result
Appearance (form)	-	Powder
Appearance (color)	-	Black
Reduced Graphene Oxide	Gravimetric	99 - 100 %
Water	Gravimetric	0-1 %
HCl	Estimated	< 1 %
Bulk density	Weighing	10 g / liter
pH	pH-meter	3-4 when suspension in water and diluted to 0.1 weight %
Smell	-	Almost odorless
rGO-layers in sheet-stacks	Raman spectroscopy	Less than 7 layers*
Zeta potential in dispersion	Zeta potentiomter	n/a
Dispersibility	Sedimentation test	Cannot be truly dispersed in any medium. Fairly well dispersed in water/isopropanol mixtures

*According to XRD and Raman Analysis

COMPOSITION AND CHEMICAL PROPERTIES

Materials property	Analytical method	Value / test result
Primary sheet thickness	XRD - Braggs equation	~ 0.34 nm
Crystallinity	XRD - Peak intensity	Broad peak around 26 deg 2θ
Crystalline phase	XRD - EVA	>99 % Reduced Graphene Oxide
Primary sheet aspect ratio	AFM - visual	n/a
Crystallinity	TEM	n/a
BET surface area	BET measurement	~ 500 m^2 / g
Chemical composition**: Carbon	XPS	99 at %
Oxygen	XPS	~ 0.6 at %
Sulfur	XPS	< 0.5 %
Nitrogen	XPS	< 0.5 %
Chloride	XPS	< 0.5 %
Metals	XPS	Not detected
C/O ratio (atomic ratio)	XPS	> 100
Electrical conductivity ($S.cm^{-1}$)	Powder compaction at 0.6MPa	1.2

**Chemical composition in weight percent from XPS analysis.

BACKGROUND DATA

LayerOne reduced Graphene Oxide (rGO) is produced by thermal reduction of graphene oxide. The product has been extensive analyzed, comprising SEM, XRD, IR, Raman, XPS and BET. For most analyses, data can be provided upon request.

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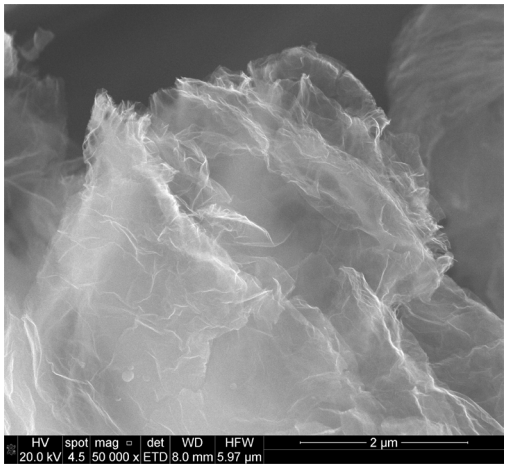
SCANNING ELECTRON MICROSCOPY (SEM)

rGO powders were evaluated by a high resolution field-emission scanning electron microscopy (HRFE-SEM; Quanta 3D FEG)) with either secondary (SE) or backscattered (BSE) electrons at an accelerating voltage of 20 kV with magnification of 50 000×.

All samples were previously metalized with a 20 nm thick gold layer deposited with a Polaron SC502 sputter coater.

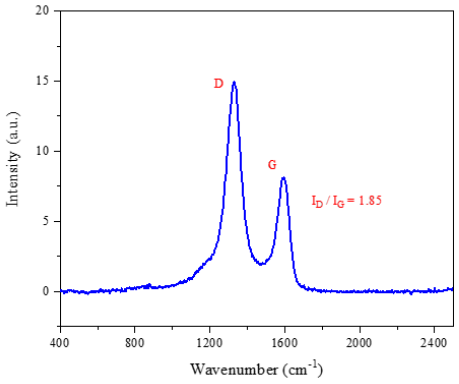


RAMAN SPECTROSCOPY

Raman spectra were obtained with laser wavelengths of 532 nm and 390 nm and a spot size of 2 µm. The Si peak at 520 cm^{-1} was used as a reference to calibrate the wave number.

The peaks at ~1330 cm^{-1} (D band) and ~1595 cm^{-1} (G band) that are commonly seen in the Raman spectra of carbonaceous materials are clear.

The ratio of intensity of D/G bands is a measure of the defects present on graphene structure. The ratio of the intensity of the D band to the G band (I_D/I_G) is calculated to be (i.e., ~ 1.9) for our rGO presenting low regime defect density.

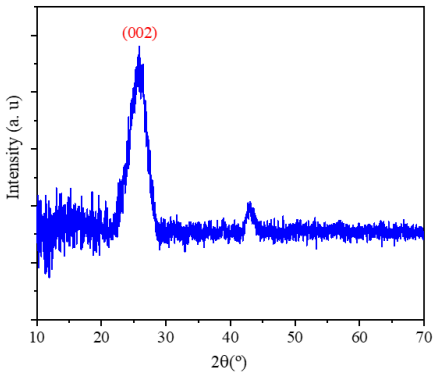


X-RAY DIFFRACTOMETRY (XRD)

X-ray diffractometry using CuKα radiation (angular interval 2–65° 2θ, and count time 4 s per step) was per formed on rGO powder.

The broad peak at around 26° corresponds to the typical (002) diffraction peak of rGO.

The spacing between the RGO sheets is calculated around 0.34 nm.



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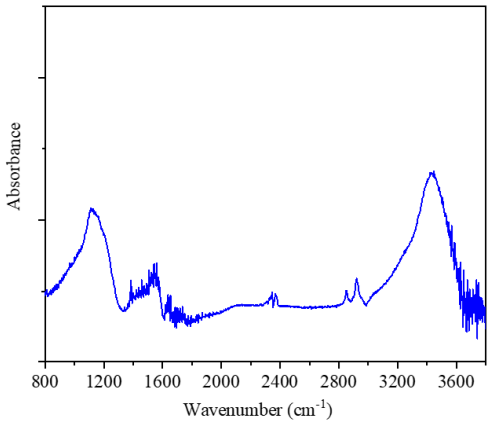
INFRARED SPECTROSCOPY (FTIR)

Fourier transform infrared (FTIR) spectroscopy was recorded with an Agilent 660 FTIR spectrometer.

The FTIR samples were prepared by dispersing the materials in KBr pellets.

The functional groups detected by FTIR are listed in the Spectrum.



Wave number (cm-1)	Functional group
800-1200	C-O
~1600	C=C
~1700	C=O
3000-3700	C-OH

Instructions for safe use

Safety
- **Read MSDS carefully before handling of product.**
- **The product is only for laboratory use by certified personnel.**
- **Use laboratory gloves. Use dust-mask.**
- **The powder is extremely light and will easily blow out of any container if exposed to draft, sneezing or the like.**

Dispersion in liquid
True, stable dispersions cannot be prepared easily unless dispersing agents can be tolerated. Extended use of high shear and / or ultrasound is recommended. Semi-stable dispersions can be obtained in e.g. water/iso-propanol-mixtures. In oils and melted waxes fairly stable dispersions can be prepared by intense stirring.

Dispersion melted polymers
Can be added to melts but if automated feeder is used, we recommend using products 2.2 or 2.3. We recommend storing in cool and dry place.

Storage
Store in closed container. Shelf life is still not known. To our knowledge, the material does not degrade over time.

LayerOne takes no responsibility for the result of any mixing with or exposure to other substances!