

With its excellent combination of low oxygen content, high conductivity, and high accessible surface area our Ultra Graphene is ready for your industrial application.

ULTRA Graphene

Single layer reduced graphene oxide with low oxygen content, high accessible surface area combined with high conductivity and catalytic activity.

Since its discovery more than a decade ago, graphene has attracted interest thanks to its unusual electrical, electronic, optical, and mechanical properties which opens the door for a wide range of technological applications. However, the production of functional graphene materials on a large scale has been challenging but Pimata has advanced its production technology where this is no longer true. Pimata offers graphene oxide and graphene products in different formulations that are designed to be customized for every kind of use. Because of this, Pimata's graphene products have the potential to revolutionize the graphene industry with applications in batteries, transparent conducting electrodes, functional inks, flexible displays, antistatic coatings, and RFID antennas to name but a few.

PRODUCT OVERVIEW

One of the major challenges that has been facing graphene since its discovery is finding a production method that has the capacity to not only produce high quality graphene but also has the potential for manufacturing large quantities. Pimata has made a lot of progress towards that end.

ULTRA Graphene reveals excellent combination of low oxygen content (3.1 at% by XPS), high conductivity (>3000 S/m), and high accessible surface area (>950 m²/g – measured by BET – nitrogen). The high surface area is manifested by an ultralow bulk density of ~0.002 g/cm³, making the material as light as air. Most importantly, the material can be processed from a wide range of solvents, while also preserving the single layer of the material, opening the door for industrial applications of graphene. With these excellent properties, ULTRA Graphene will find its role in numerous industries including but not limited to:

- batteries
- supercapacitors
- sensors
- conductive films
- transparent conducting electrodes
- electronics
- functional inks
- composites
- catalysis
- fuel cells
- lubricants
- composites
- catalysis
- fuel cells
- lubricants
- anti-corrosion coatings
- antistatic coatings
- thermoelectric devices
- hydrogen storage
- water filtration
- environmental remediation
- RFID antennas
- structural materials

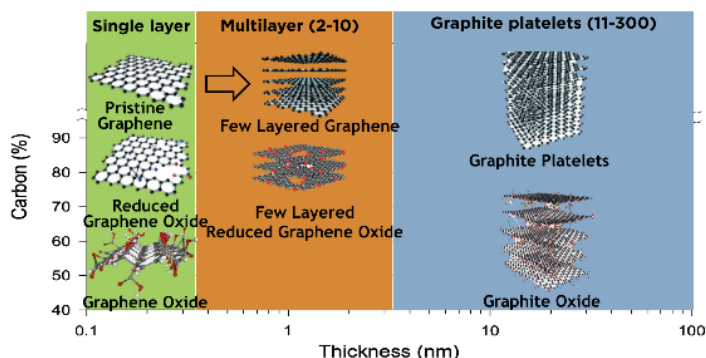


Item #: 902160	
Product Specifications*	
Appearance	Fluffy powder
Color	Black
Odor	Odorless
Manufacturing Method	Reduction of GO
Carbon Content (XPS)	96.5 at%
Oxygen Content (XPS)	3.1 at%
Ash	<0.5 at%
Solubility in Water	Insoluble
Dispersibility	Dispersible at low concentrations in ethylene glycol, isopropanol, ethyl acetate, chloroform, DMF, NMP, THF, and dichlorobenzene
Surface Area - BET nitrogen	951±64 m²/g
Electrical Conductivity	3500±500 S/m
Apparent (tapped) density	0.0015 - 0.0030 g/cm³
Particle Size Distribution of Bulk Powder ¹	D10: 7.09 µm; D50: 12.1 µm; D90: 19.3 µm
Lateral Size of rGO Flakes ²	D10: 0.20 µm; D50: 0.36 µm; D90: 0.65 µm

1. Conducted using a Horiba LA-960N laser scattering particle size analyzer.

2. Calculated using SEM of a rGO film casted from a rGO dispersion on a silicon wafer after a few minutes of probe ultra-sonication.

** All numbers listed in this sheet have been confirmed by third party testing and done according to the ISO standard: ISO TS 21356-1 2021*



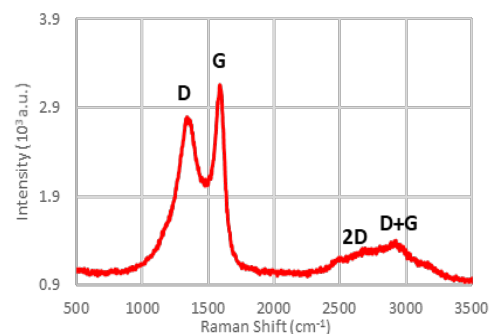
ELEMENTAL ANALYSIS

Carbon	85-88 wt%
Hydrogen	0.7-0.9 wt%
Nitrogen	<0.3 wt%
Oxygen	2-6 wt%

From elemental analysis, oxygen content of ULTRA Graphene goes further down to ~5 wt%, showing effective removal of most oxygen containing functional groups from graphene oxide.

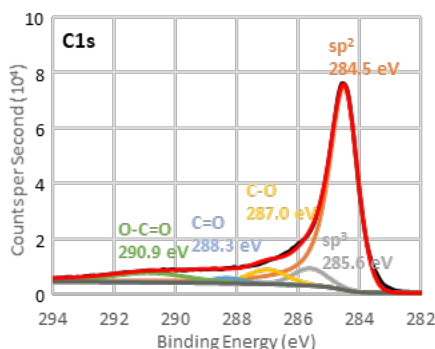
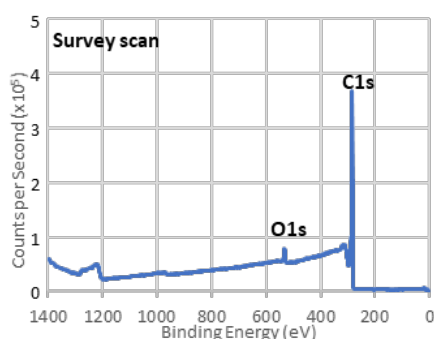
RAMAN SPECTROSCOPY

The Raman spectrum of ULTRA Graphene features the D band at 1350 cm^{-1} , the G band at 1580 cm^{-1} and the appearance of the 2D band at 2690 cm^{-1} and the D+G band at 2900 cm^{-1} after the reduction of GO verifying the recovery of sp^2 conjugation in ULTRA Graphene.



XPS ANALYSIS

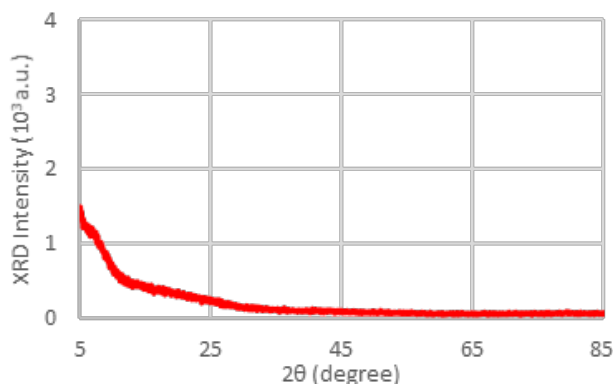
The purity of ULTRA Graphene is further demonstrated from XPS analysis, showing the dominance of carbon (96.5 at%) with small content of oxygen (3.1 at%). The high-resolution C1s spectrum of ULTRA Graphene confirms the recovery of sp^2 carbon (68.8%) in comparison with sp^3 carbon (7.4%), C-O (7.2%), C=O (2.3), and O-C=O (9.4%).



C Species	Peak BE (eV)	Percentage (%)
sp^2	284.5	68.8
sp^3	285.6	7.4
C-O	287.0	7.2
C=O	288.0	2.3
O-C=O	290.9	9.4

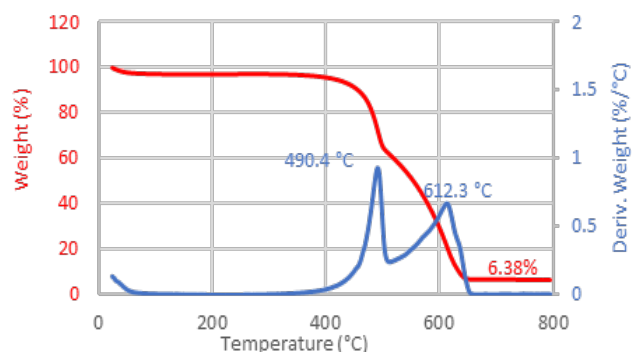
X-RAY DIFFRACTION

The powder XRD pattern of ULTRA Graphene is featureless across the spectrum range (5-45°), confirming the true exfoliated monolayer nature of the material.



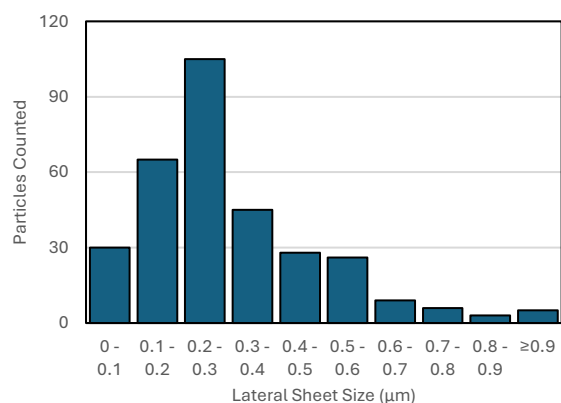
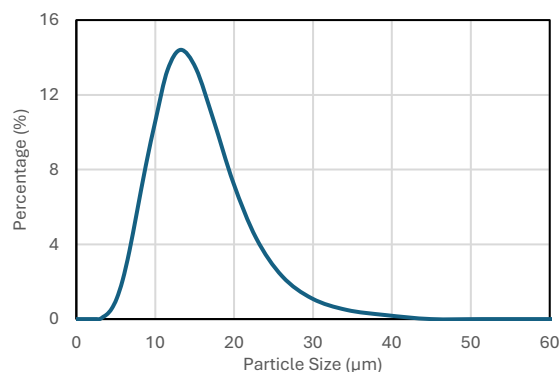
THERMAL ANALYSIS

ULTRA Graphene is stable against heat in AIR at temperatures approaching 500 °C, undergoing complete combustion at about 490 and 610 °C.



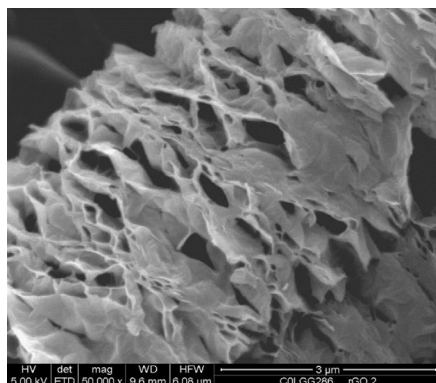
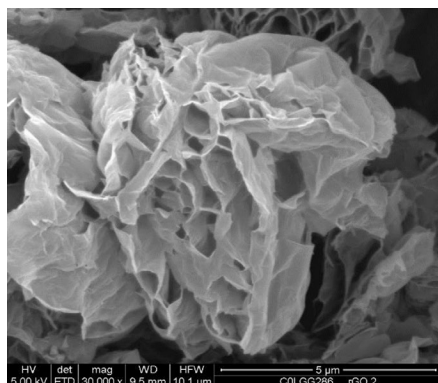
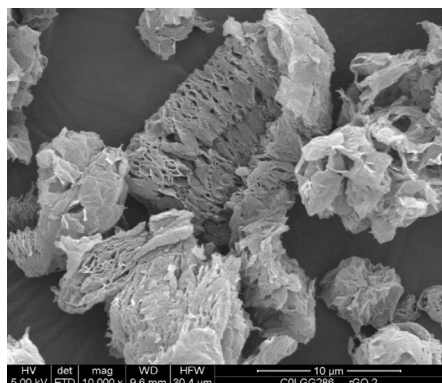
PARTICLE SIZE DISTRIBUTION

The particle size distribution of the ULTRA Graphene bulk powder was measured using a Horiba LA-960N laser scattering particle size analyzer, showing D10 of 7.09 μm , D50 of 12.1 μm , and D90 of 19.3 μm . When dispersed into various polar solvents, ULTRA Graphene can resume the individual nanosheet state and uniformly casted onto various substrates, exhibiting the flake size distribution with D10 of 0.20 μm , D50 of 0.36 μm , and D90 of 0.65 μm .



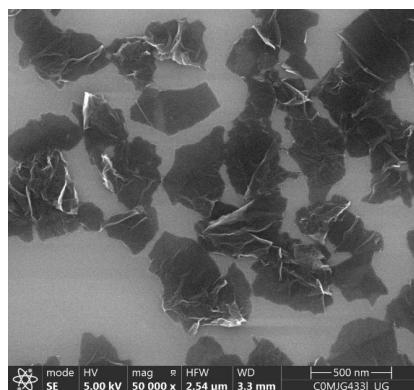
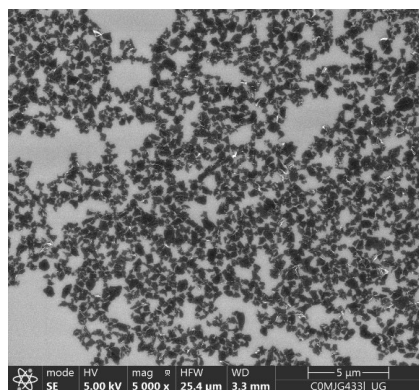
SEM IMAGING (BULK POWDER)

Ultra Graphene powders under SEM exhibit a foam-like structure that is fully expanded and made of individual graphene nanosheets. Because of its unique structure, the material demonstrates remarkable surface area and electronic conductivity.



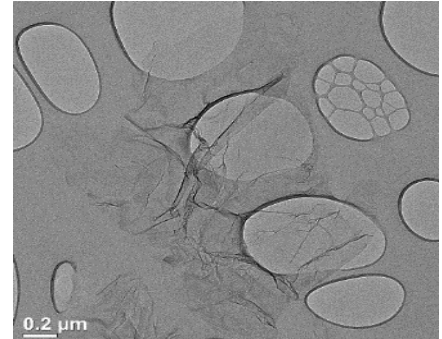
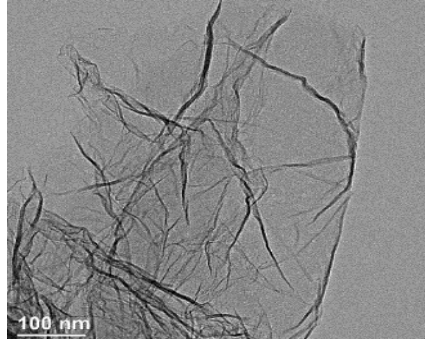
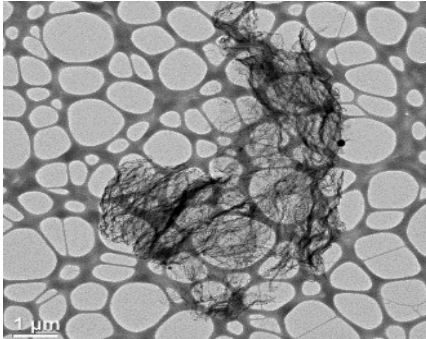
SEM IMAGING (DISPERSED NANOSHEETS)

After dispersing into solution, ULTRA Graphene can be casted onto various substrates with little to no restacking due to the “unflatness” of the graphene nanosheets.



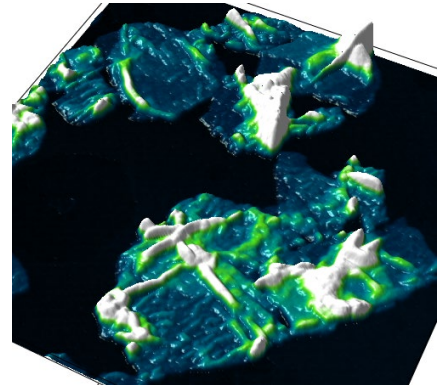
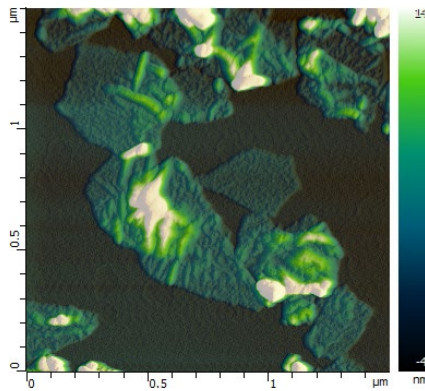
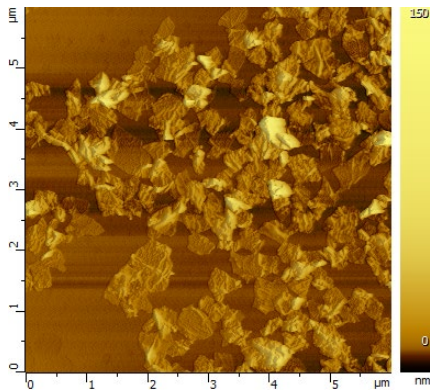
TEM IMAGING

TEM images of the graphene powder (without liquid solution processing) reveal the individual graphene nanosheets, the basic building blocks that make up the 3D framework of ULTRA Graphene. Although the dry particles are made up of hundreds of graphene sheets, the particles (image on the left) appear transparent to the electron beam, again confirming the well-separated graphene sheets in the product. This was made possible through the introduction of massive wrinkles and ridges in the basal planes of graphene. This unique structure prevents the collapse and restacking of graphene sheets under the influence of van der Waals interactions.



AFM MICROSCOPY

AFM provides additional confirmation for the SEM and TEM results. A graphene film coated onto freshly cleaved mica shows the numerous wrinkles and crumpling in the basal planes of graphene, which again contribute to the higher surface area of the material.



HOW TO DISPERSE GRAPHENE

ULTRA Graphene can be dispersed in organic or aqueous solutions containing a surfactant by applying a mechanical force such as shear mixing, ultrasonic agitation or even ball milling. Solvents for the dispersion of ULTRA Graphene include: ethylene glycol, isopropanol, ethyl acetate, chloroform, DMF, NMP, THF, and dichlorobenzene. To get the best results, we recommend that our customers disperse ULTRA Graphene powders using concentrations up to 0.5 mg/mL, probe sonicate or shear mix the solution for 15 minutes, and centrifuge to remove the large particles.



From left to right, dispersions of ULTRA Graphene in ethylene glycol, isopropanol, ethyl acetate, chloroform, DMF, NMP, THF, and dichlorobenzene at 0.1 mg/mL. The dispersions show excellent stability over time even when tested after one week.

Disclaimer: The information claimed is believed to be accurate. Pimata holds no guarantee to the accuracy of data and no liability in connection with damages when using the product.

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