GRUPO ANTOLIN

ACM Advanced Carbon Materials

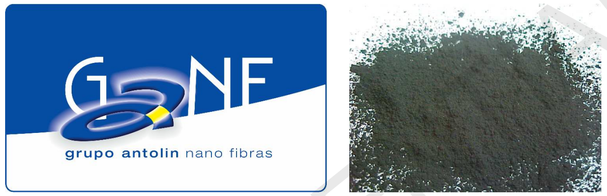
R&D&I activities funded by CDTI

Disclaimer

This Confidential Presentation (the “Presentation”) has been prepared by Grupo Antolin-Irausa, S.A. (the “Group”) for information purposes only. The distribution and use by recipients of the information contained herein and any other information provided to the recipient by or on behalf of the Group or its representatives is strictly confidential and the recipients bind themselves to strictly limit within their respective organization the circulation, copying and disclosure of the information contained in the Presentation. Except with the expressed consent of the Group, you may not use, distribute, sell, modify, revise, republish, post or create derivative works (where applicable) of the trademarks, logos, information or other material or content in this Presentation. The Group has prepared this Presentation with due care based on available information; however, it does not accept any liability whatsoever for the contents or interpretation of the information provided herein. The Group makes no representation or any other form of assurance as to the accuracy or completeness of the information in this document.

Introduction

- **Grupo Antolin was the first European producer of carbon nanofibers at industrial scale using the continuous production process known as “floating catalyst technique”.**

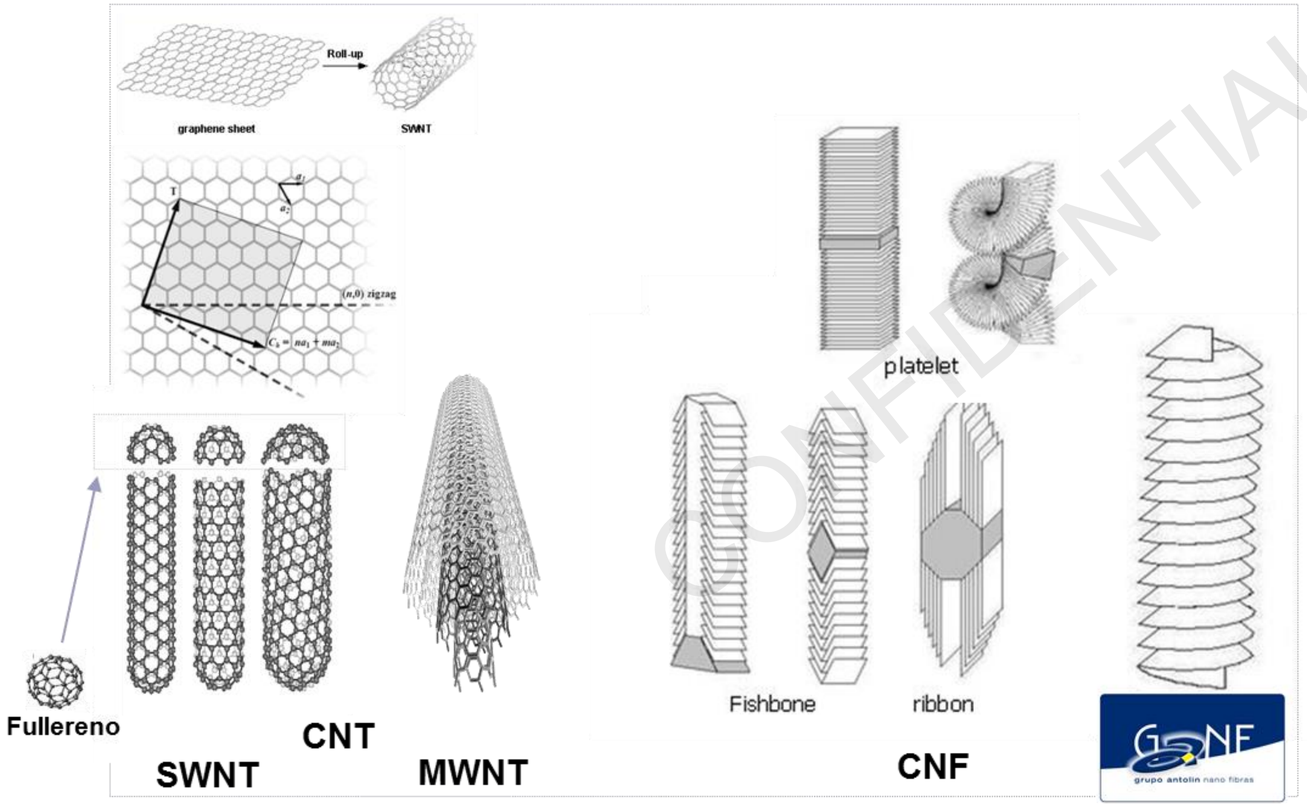


- **Grupo Antolin division of Advanced Carbon Materials provides high quality graphene products obtained from CNFs since 2010.**

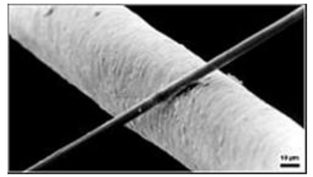
- **ACM technologies are protected by 8 patents: Production process of graphene, reduced graphene oxide and graphene oxide obtained from CNFs. Carbon nanofiber production and tailoring for different applications.**

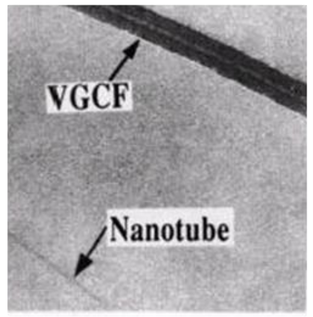
ACM Advanced Carbon Materials

Graphitic Nanofilaments and graphene



Human hair diameter vs. micrometric carbon fibre



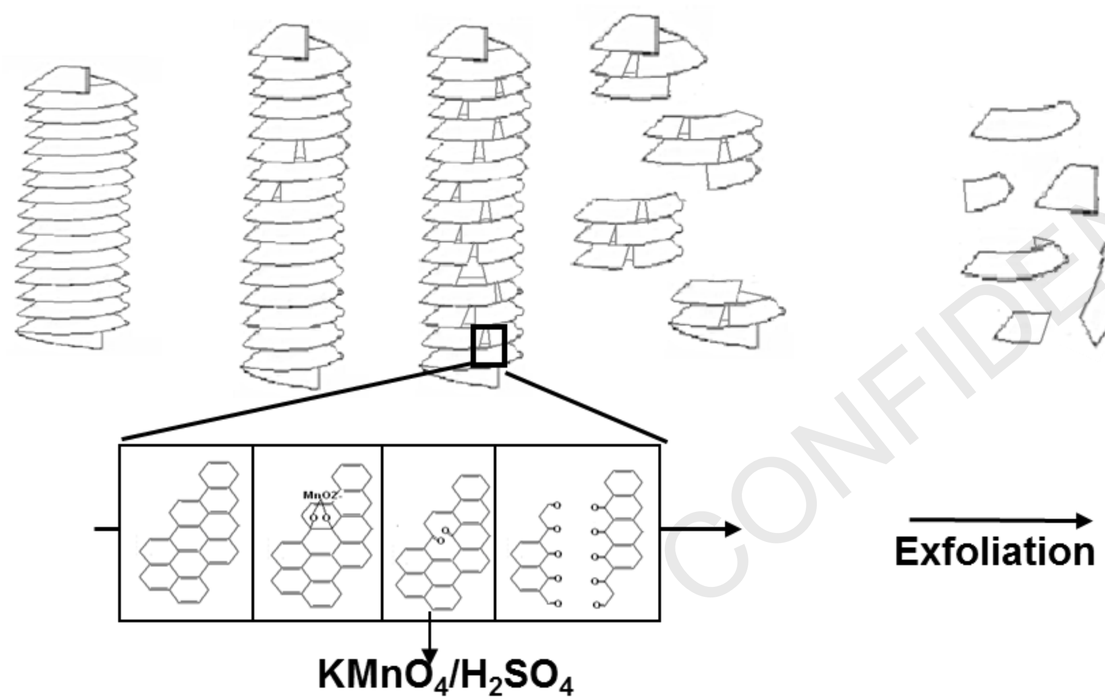


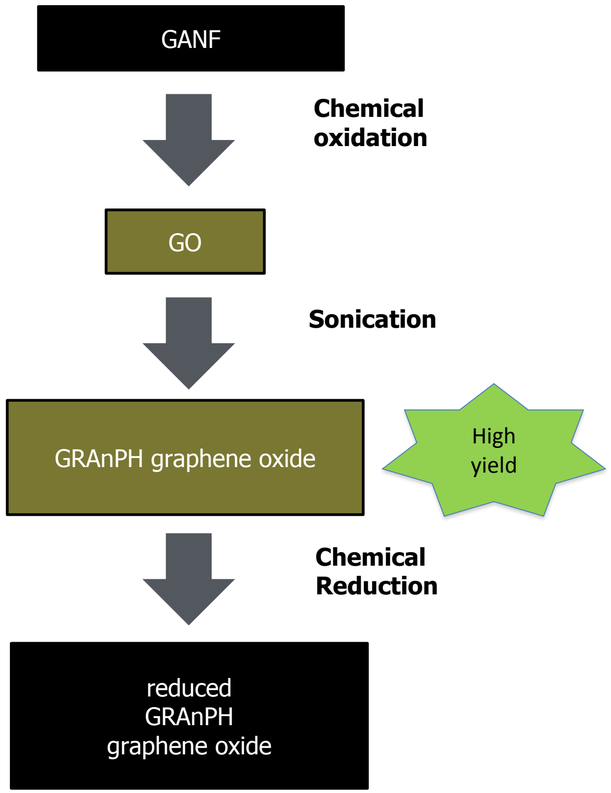
Micrometric carbon fibre vs. carbon nanotube

ACM Advanced Carbon Materials

Graphene Oxide obtained from GANF

- **Chemical oxidation (unzipping and fragmenting) + sonication (exfoliation of GO sheets in liquid media).**

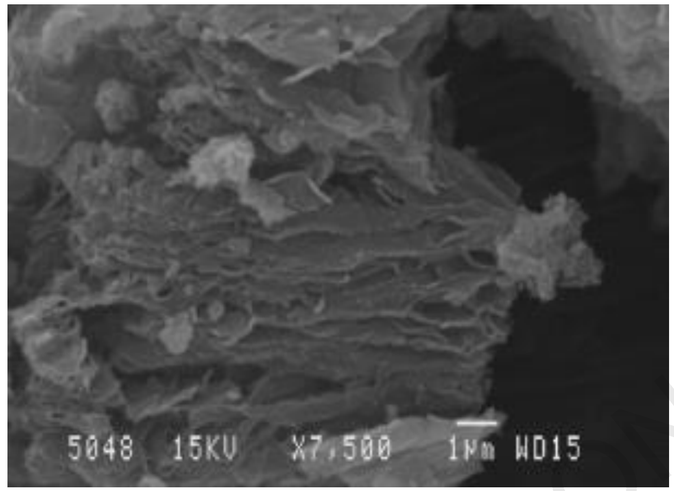


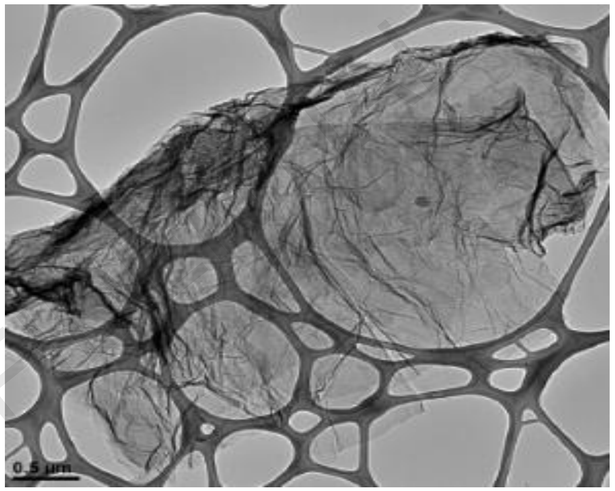


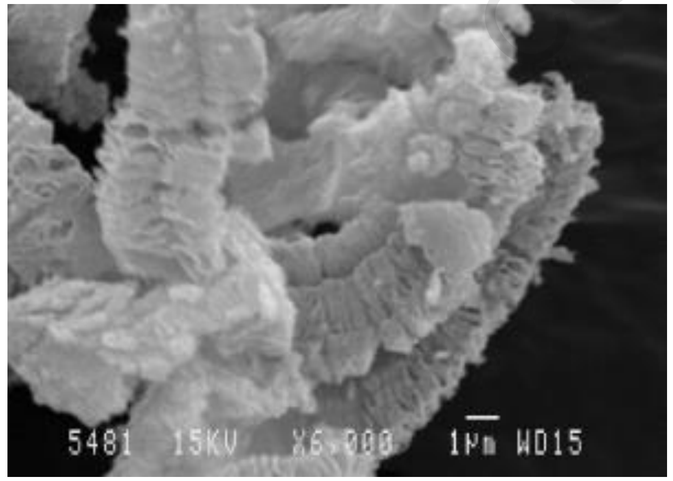
- **Main advantages versus GO obtained from graphite:**
  - **High purity and reproducibility.**
  - **Production of mainly single and few layers graphene oxide sheets.**

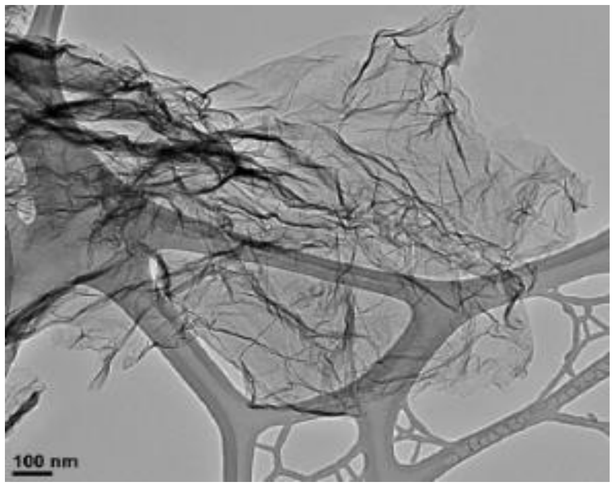
Powdered thermally reduced and exfoliated GO

- **High surface area rGO is obtained by thermal expansion of GO obtained from GANF:**



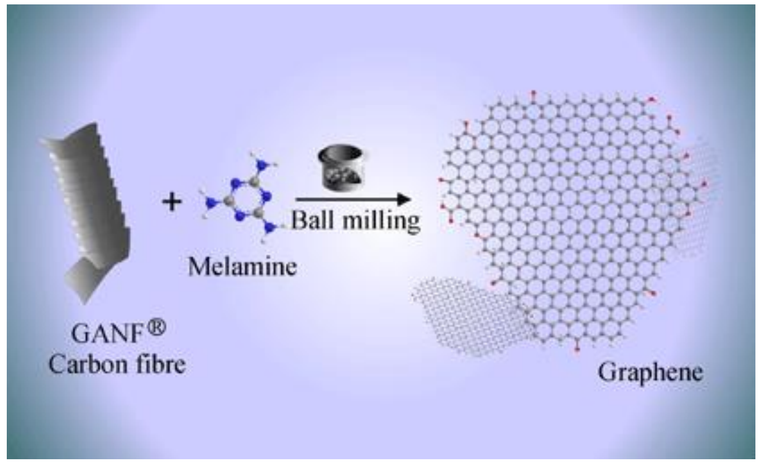






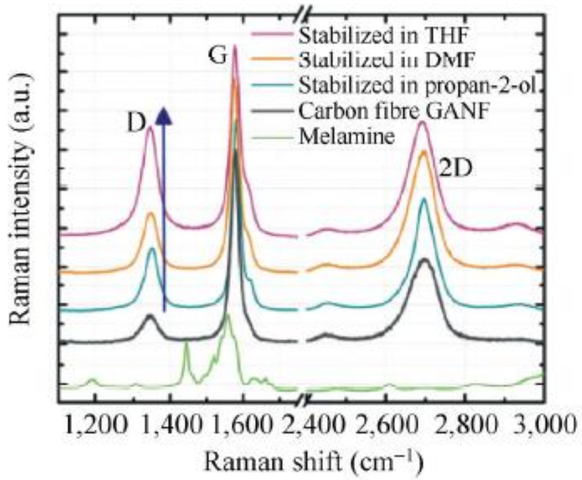
Pristine graphene obtained from GANF

- **Mechano-chemical treatment (milling and intercalation) and subsequent sonication (exfoliation) in appropriate solvents.**



Elemental analysis

Sample	C%	H%	N%	O%
Carbon fibre GANF®	98.44 ±0.05	0.06 ±0.02	0.01 ±0.0	1.5 ±0.07
Exfoliated graphene	93.57 ±0.27	0.39 ±0.02	0.29 ±0.01	5.51 ±0.251



Dispersion: Intermediate products

- Grupo Antolin has developed different dispersion technologies for achieving good dispersion of CNFs and GRAnPH in some composite end products.
- Most of our sales are intermediate products.
- Easier to be used by customers and higher added value for ACM.

GAcomp

- Thermoset polymers doped with CNFs or GRAnPH.
- Applications related to sports, aeronautics, etc.

GAqUA

- Dispersions of GRM in water.
- Applications related to adhesives, etc.

IQNet THE INTERNATIONAL CERTIFICATION NETWORK CERTIFICATE

ISO 9001:2008

ACM Patents

- EP1598455, C. Merino, P. Soto, **“Furnace and procedure for the manufacture of carbon fibres and the fibre thus obtained”**, 2004.
- EP1602754, C. Merino, A. Melgar, **“Gas reusing system for carbon fibre manufacturing process”**, 2004.
- EP1990449, J.L. González, J. Vera, C. Merino, I. Martín, **“Carbon nanofibers and procedure for obtaining said nanofibers”,** 2007.
- EP2107140, C. Merino, J.L. González, **“Procedure for elimination of polycyclic aromatic hydrocarbons and other volatile and semi-volatile compounds in carbon nanofibres”**, 2008.
- EP2489632, C. Merino, I. Martin-Gullon, H. Varela, Mª Pilar Merino, **“Process for obtaining graphene oxide nanoplatelets or graphene nanoplatelets, and the graphene oxide nanoplatelets thus obtained”**, 2011.
- EP2767511, C. Merino, P. Merino, E. Vázquez, E. del Río, V. León, **“Process for obtaining a uniform dispersion of graphene platelets in a liquid and the product thereby obtained”**, 2014.
- EP2886621, C. Merino, P. Merino, **“Adhesive for the manufacture of laminates of cellulose products and manufacturing procedures of laminates of cellulose products”**, 2013.
- EP2899159, C. Merino, P. Merino, S. Blanco, **“Process for obtaining stable dispersions of aggregates of graphenic nanofilaments in water”**, 2014.

FIT-030000-2000-173	PROFIT	2000	DESARROLLO DE TECNOLOGÍA DE FABRICACIÓN DE FIBRAS CORTAS DE CARBONO (VGCF) Y SU APLICACIÓN EN EL SECTOR DE AUTOMOCIÓN
FIT-030000-2001-286	PROFIT	2001	DESARROLLO DE TECNOLOGÍA DE FABRICACIÓN DE FIBRAS CORTAS DE CARBONO (VGCF) Y SU APLICACIÓNEN EL SECTOR DE AUTOMOCIÓN
FIT-030000-2002-224	PROFIT	2002	DESARROLLO DE APLICACIONES DE SUBMICROFIBRAS DE CARBONO (s-VGCFs) EN DIFERENTES SECTORES

FIT-030000-2004-62	PROFIT	2004	ESTUDIO Y CARACTERIZACIÓN DE NANOFIBRAS DE CARBONO (s-VGCF's) PRODUCIDAS EN REACTOR CERÁMICO, DE SU TRATAMIENTO Y COMPATIBILIZACIÓN CON MATERIALES TERMOPLÁSTICOS PARA SU UTILIZACIÓN EN AUTOMOCIÓN O EN SUPERCAPACITORES
FIT-420000-2005-13	PROFIT (Eureka)	2005	DETERMINACIÓN DE LOS PARÁMETROS NECESARIOS PARA EL AJUSTE ÓPTIMO DE LA RESISTIVIDAD ELÉCTRICA OBJETIVO DE COMPUESTOS TERMOPLÁSTICOS CON NANOFIBRA DE CARBONO, INDEPENDIENTEMENTE DEL TIPO DE TERMOPLÁSTICO EN EXTRUSIÓN Y EN INYECCIÓN

04/05/BU/0010 - FIT 030000-2006-94	ADE/PIIC/PROFIT	2005-2006	OPTIMIZACIÓN DE LOS PROCESOS DE OBTENCIÓN Y MODIFICACIÓN SUPERFICIAL DE NANOFIBRAS DE CARBONO PARA SU APLICACIÓN COMO REFORZANTE Y FUNCIONALIZANTE DE MATERIALES AVANZADOS EN DISTINTOS CAMPOS TECNOLÓGICOS
FIT-420000-2006-10	PROFIT (Eureka)	2006	INCREMENTO DE LAS PRESTACIONES DE PROTOTIPOS MEDIANTE LA ELABORACIÓN DE MATERIALES TERMOPLÁSTICOS CARGADOS CON NANOFIBRAS DE CARBONO PARA EL AJUSTE DE LA RESISTIVIDAD ELÉCTRICA
FIT-030000-2006-273	PROFIT EN COOPERA-CION	2006	DESARROLLO Y OBTENCIÓN DE MATERIALES COMPUESTOS Y PRODUCTOS INDUSTRIALES INNOVADORES BASADOS EN LA UTILIZACIÓN DE NANOFIBRAS DE CARBONO

CEN 20071001	CENIT DOMINO	2007-2010	DESARROLLO Y OBTENCIÓN DE MATERIALES INNOVADORES CON NANOTECNOLOGÍA ORIENTADA

IDI – 20100272	INTEGRADO NEWIND	2009-2012	Tecnologías avanzadas en generación de energía eólica
IB!09-627	IBEROEKA NANOINTER-POL	2010-2012	Materiales Compuestos de Nanoestructuras de Carbono en Matrices Poliméricas: Efecto de la Interfase sobre las Propiedades Mecánicas y Eléctricas

CEN-20091014	CENIT INFINITEX	2009-2012	Investigación de Nuevas Funcionalidades e Inteligencia Implementadas en Textiles

IDI-20111312	INTEGRADO GRAnPHTEC	2011-2013	Obtención de Nanoplaquetas de Óxido de Grafeno a partir de Nanofibras de Carbono, Purificación, Reducción y Depósito controlado de las mismas

IDI-20150671	CIEN SPECTRA	2015-2018	SMART PERSONAL CO2 FREE TRANSPORT IN THE CITY

1999

Spanish National Research Council (CSIC).
CNF research launch.

2003

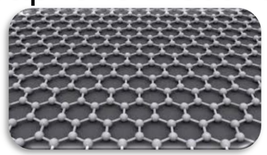
1st Pilot furnace for CNF production

2004

CNF Production.
1st Semi-industrial furnace

2004

Graphene Discovery



2007

2008

CNFs Surface treatment

2010

2010

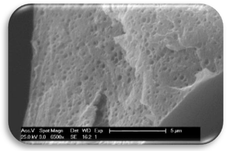
Nobel Prize

2011

European Patents: Graphene obtaining

2017

1st Autom. Headliner



2018

Advanced Carbon Materials applications under development in several research programs.

www.grupoantolin.com

sales.ga-acm@grupoantolin.com

+34 947 47 77 00