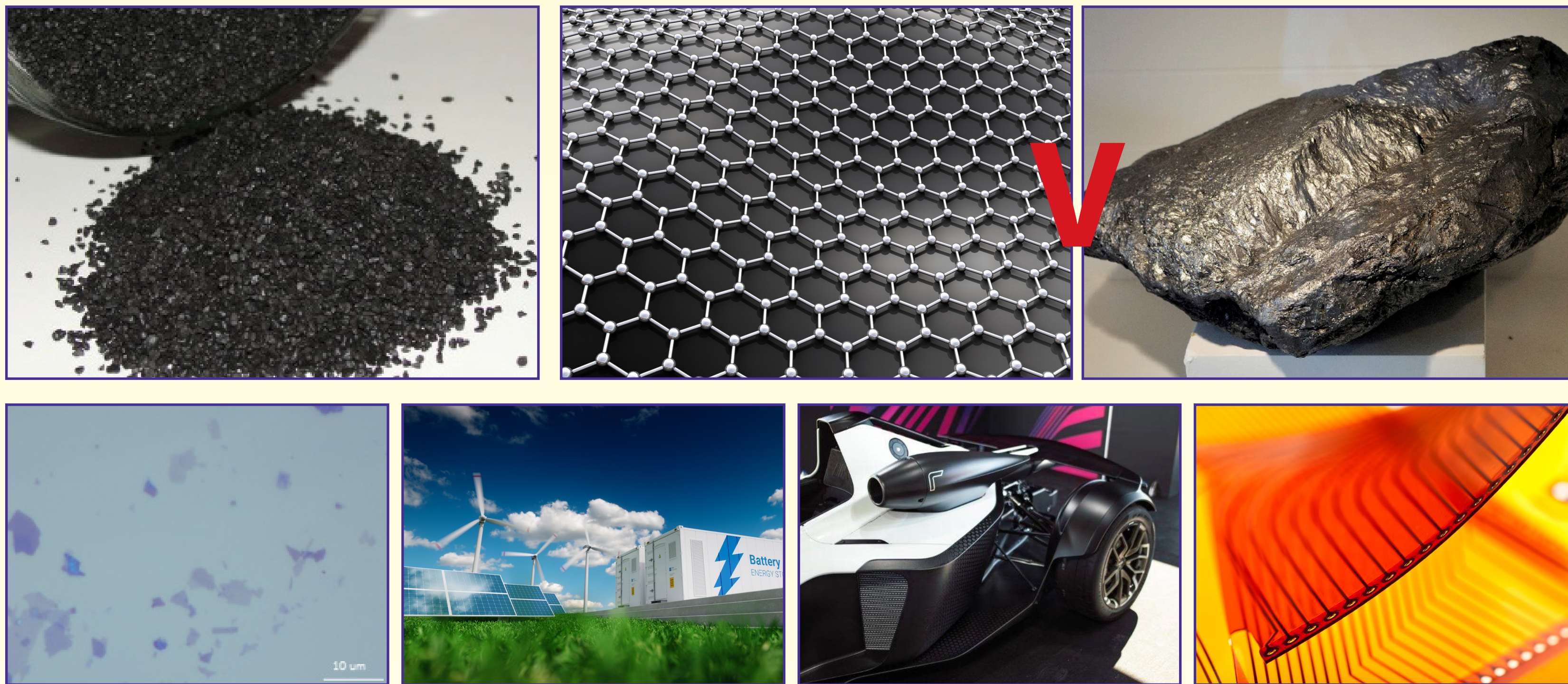


# ISO G-Scope

## Standardisation of structural and chemical properties of graphene

### Need

- Graphene is a single layer of carbon atoms, typically sold in flake (powder/dispersions) form as few-layer graphene (FLG), graphene oxide or other chemically functionalised graphene.
- Remarkable properties - Light weight, high strength, high thermal and electrical conductivity, etc
- Multi-billion application markets: composites, aerospace, automotive, energy storage, batteries, photovoltaics, batteries, flexible electronics, consumer products, novel coatings and clothing
- Global market size of graphene material by itself of ~ € 200 – 2000 million by 2025
- Issue: 100+ commercial 'graphene' producers. But what is my material?
- Compliance with REACH (2006/1907) and new annexes (2018/1881). Environment, Health and Safety requirements
- Validation and standardisation of structural and chemical measurement methods is critical



### Objectives

To validate and standardise measurement and characterisation methods for the chemical and structural characterisation of graphene in powders and liquid dispersions for industrial applications:

1. To lead "ISO TS 21356-1 Nanotechnologies – Structural characterisation of graphene: Part 1: Graphene from powders and dispersions" to publication and revision including validated measurement methods (WP1, WP2, WP3).
2. To lead "ISO/PWI 23359 Nanotechnologies - Chemical characterisation for graphene in powders and suspensions" and "ISO/PWI 23879 Nanotechnologies – Structural characterisation of graphene oxide flakes: thickness and lateral size measurement using AFM and SEM" (WP2, WP4).
3. Pre-normative international interlaboratory studies in VAMAS TWA 41 (graphene and related 2D materials) on structural and chemical measurements using AFM & SEM, Raman spectroscopy and XPS (WP2, WP3, WP4).
4. To work closely with ISO, CEN, commercial users and the EU Graphene Flagship, to ensure that the outputs of the project are aligned with their needs (WP1, WP5).

### WP1 Documentary standardisation

### WP2 Sample preparation

### WP4

Functionalised graphene and GO VAMAS

### WP3

VAMAS graphene structural

### WP6 Management & coordination

### WP5 Creating impact

Early and late stage workshops  
Host ISO TC229 meeting  
Partner with EU Graphene Flagship, Graphene stakeholder communities  
Social media, webinars, open data, website, publications, trade articles, standard operating procedures - International standards  
Provide support for measurement lab, producers, buyers and users of graphene/GO



### Beyond state of the art

- Develop protocols for sample preparation, measurement and data analysis.
- Validate via 4 VAMAS International interlaboratory studies.
- Reduce uncertainties in industrial measurements.

Technique/measurand	Measurement uncertainty		Main issue
	Before	After	
AFM (graphene) - lateral flake size - thickness	5-10% 20%	~1% ~5%	Piezo-electric scanner Sample preparation protocol
SEM (graphene, GO) - lateral flake size	3-5%	<1%	Dimensional calibration Image analysis
Raman spectroscopy (graphene) - number of layers - level of disorder	< 2 layers 30%	~ 1 layer <10%	Raman spectroscopy calibration Data analysis
XPS (GO, functionalised graphene) - O/C ratio and chemistry	55%	10% – 20%	Intensity scale calibration Contamination/sample handling

### Input to Standards

- Lead development of 3 x ISO standards
- Publish 1 x CEN EN standard
- Run 4 x Interlaboratory studies under international VAMAS TWA 41 committee
- Contribute to other relevant ISO TC229 and IEC TC113 standards in terminology, measurement health and safety and material specification
- Interaction with 8+ other national, European and international committees: ISO/TC 201, ISO/TC 229, CEN/TC 352 etc.

