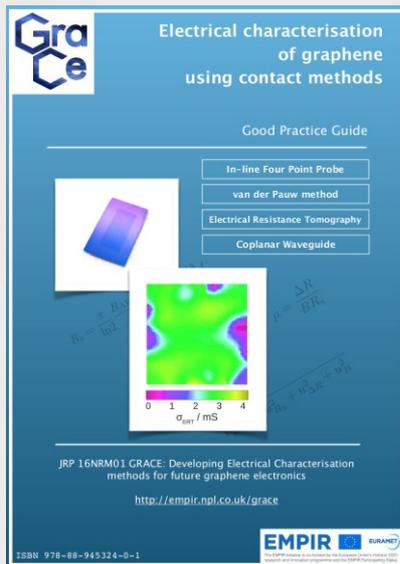


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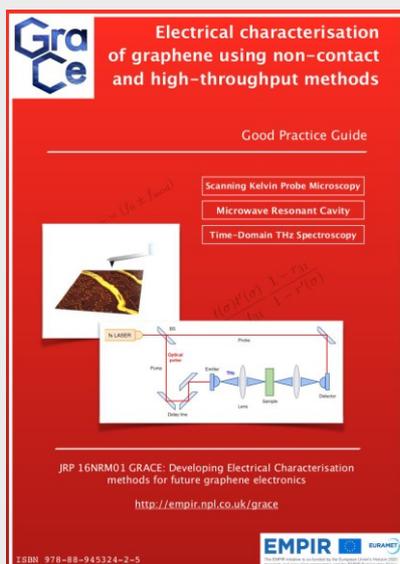
EMPIR | 16NRM01 | GRACE

Good Practice Guides

Two GPGs, published by the GRACE consortium, are available in open access



ISBN: 978-88-945324-0-1



ISBN: 978-88-945324-2-5



Developing electrical characterisation methods for future graphene electronics

Delivering Metrology to the Graphene Industry

The adoption of **graphene as an electronic industrial product** is currently limited by the inability to grow large areas of high-quality graphene with **uniform and reproducible** electric and electronic properties.

The issue has been highlighted by **standard organisations** such as the International Electrotechnical Commission (IEC) and the European Committee for Electrotechnical Standardisation (CENELEC).

EURAMET responded to the **need to initiate metrology projects at the European level** on the issue of the characterisation of graphene and 2D atomic materials for electrical applications.

The GRACE project stems from that need.

The project's specific objectives can be summarized as follows:

1. Development of an accurate and traceable approach for the electrical characterisation of graphene through contact and non-contact methods, with traceability to the electrical SI units.
2. Validation of a high-throughput approach for the electrical characterisation of graphene.
3. Dissemination of metrology and methodologies established in this project in the form of good practice guides.
4. Contribution to standardization activities of the technical committees IEC/TC113 and TC119 through the initiation and development of new written standards for the electrical characterisation of graphene.

<http://empir.npl.co.uk/grace/>



Closing Remarks

After three years (2017-2020), the GRACE project is successfully closed.

Its objectives and deliverables have been comprehensively fulfilled.

The project's output, in terms of scientific production and input to the stakeholders, is going well beyond what was planned.

The GRACE project actively involved 32 researchers and experts in material science, electrical measurements and documentary standards.

The Stakeholder Committee has 12 members from 7 countries.

What was a project consortium is now a community of people, who have shared needs, experience and successes, and are eager to work together again in the future.

Luca Callegaro
Alessandro Cultrera
(INRIM, coordinator)

GRACE Consortium

Partners:

INRIM, NPL, UoM, CEM, Graphenea, das-Nano, VDE, ISC.

Collaborators:

Politecnico di Torino

Stakeholders:

NIST (US), LNE (FR), FORTH (GR), Universidad de Salamanca (SP), Graphene-XT (IT), Hellenic Metrology Institute (GR), Institute of Nanoscience and Nanotechnology "Demokritos" (GR).

Read the GRACE Newsletter at:

<http://empir.npl.co.uk/grace/news-and-events/>

GRACE Output and Impact

The output of the GRACE project at M36 includes typical research products like peer-reviewed journal papers, conference contributions in form of talks and posters, but also several inputs to the industry (in form of training workshops) and to standardization bodies (in form of draft technical specifications). Finally, substantial scientific outreach was delivered to the general public on mainstream media.

Project Output	No. of items
Open access Scientific Publications	9 (+3*)
Conference presentations & posters	27
Standardization Activities	14
Training activities	14
General Public Outreach	38

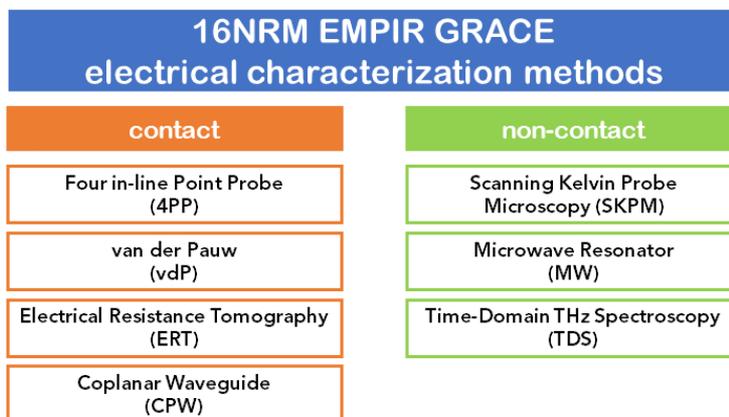
(* Papers under consideration)

Since the beginning of the project, 9 manuscripts were published, 3 more are currently under consideration.

Two Good Practice Guides have been published by the consortium. These are entitled respectively "Good Practice Guide on the electrical characterisation of graphene using contact methods" and "Good Practice Guide on the electrical characterization of graphene using non-contact and high-throughput methods" (see the covers on the side columns).

The project and its outcomes were presented at 27 events, giving focus to the status of graphene standardization and its contribution to the commercialization:

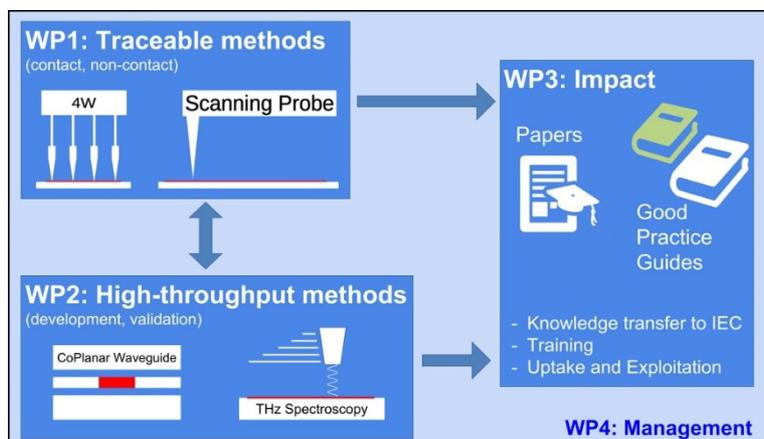
The GRACE GPGs have been accepted and distributed among IEC/TC 113 experts as input to new documentary standards. IEC also advertised the GPGs on social media channels. GRACE reported the scientific status of the project at all IEC/TC 113 meetings which took place during the EMPIR project duration.



GRACE bibliography on the electrical characterization of graphene

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- 16NRM01 EMPIR GRACE consortium, "Good Practice Guide on the electrical characterisation of graphene using non-contact and high throughput methods", Edited by A. Fabricius, A. Cultrera and A. Catanzaro, ISBN: 978-88-945324-2-5, available online at: [www. http://empir.npl.co.uk/grace/](http://empir.npl.co.uk/grace/) (2020)
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GRACE work-package structure



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