

## **Business Plan for the CENELEC Workshop on**

### **Specifications for Graphene Related Material**

#### **1. Status of the Business Plan**

The Workshop Business Plan was approved at the Kick-off meeting held on 11-12 March 2015 in Bilbao.

#### **2. Background to the Workshop**

Graphene – a single layer of carbon atoms – was first produced in labs only ten years ago but may be the most amazing and versatile substance available to mankind. This statement is made on the website of the Graphene Flagship, the EU's biggest research initiative ever, and, according to the European Commission, 'history's greatest distinction for excellent research'. The Graphene Flagship is tasked with taking graphene from the realm of academic laboratories into European society, thus generating economic growth, new jobs and new opportunities for Europeans as both investors and employees.

Graphene is remarkably strong for its very low weight (approximately 100 times stronger than steel) and it conducts heat and electricity with great efficiency. Thus, future applications range from conductive inks, transistors, li-ion batteries, transparent conductive films, supercaps and others. The global market for graphene is reported to have reached \$9 million by 2014 with most of these sales being concentrated in the semiconductor, electronics, battery energy and composites (see <http://en.wikipedia.org/wiki/Graphene>). In 2024 the world-wide graphene market will be around \$400 million according to IDTechEx which equals a growth of more than 300% each year. As far as the proposers of this workshop are informed, there is no legislations at national or European level directly linked to graphene.

On January 28, 2013 the EU announced the two winners of the Future & Emerging Technologies (FET) Flagship initiative. These Flagships are "visionary, large-scale, science driven research initiatives which tackle scientific and technological challenges across scientific disciplines". One of them is the Graphene Flagship. With the Graphene Flagship, Europe has launched a coordinated research initiative of unprecedented scale. The Graphene Flagship brings together an academic-industrial consortium aiming at a breakthrough for technological innovation. The research effort will cover the entire value chain, from materials production to components and system integration, and targets a number of specific goals that exploit the unique properties of graphene.

The Flagship is currently within the 30 months preparatory phase with the potential that the initiative may be extended up to 10 years with a total budget of 1 billion Euro. For the last 18 months of the preparatory phase starting October 2014 a call for consortium extension was announced which includes standardization as a new topic within the research programme. Currently the new topics will be integrated into the overall Flagship programme. The Graphene Flagship Standardization Committee (GFSC) has been established to coordinate all standardization activities within the Flagship with the clear target to develop standards which are required to support the scientific research programme and dissemination of the results into production of graphene related products on an industrial scale. The workshop has the intention to align the activities of the GFSC with international standardization.

The first standards related to graphene are already under development. Within IEC/TC 113 the following activities are on the agenda:

- IEC/TS 62565-3-1 Ed. 1.0 "Nanomanufacturing - Material specifications - Part 3-1: Graphene - Blank detail specification"
- IEC/TS 62565-3-2 Ed. 1.0 "Nanomanufacturing - Material specifications - Part 3-2: Graphene - Detail specification for nano-ink"
- IEC/TS 62607-6-1 Ed. 1.0 "Nanomanufacturing - Key control characteristics - Part 6-1: Graphene - Electrical characterization"
- IEC/TS 62607-6-2 Ed. 1.0 "Nanomanufacturing - Key control characteristics - Part 6-2: Graphene - Evaluation of the number of layers of graphene"
- IEC/TS 62607-6-3 Ed. 1.0 "Nanomanufacturing - Key control characteristics - Part 6-3: Graphene - Evaluation of the defect level in the graphene layer"
- IEC/TS 62607-6-4 Ed. 1.0 "Nanomanufacturing - Key control characteristics - Part 6-4: Graphene - Non-contact conductance measurement using resonant cavity"
- ISO/TS 80004-13 'Nanotechnologies - Vocabulary - Part 13: Graphene and other two dimensional materials'
- ISO/TR 19733 " Matrix of characterization and measurement methods for Graphene"

Even though IEC/TC 113 deals with the characterisation or specification of GRM we see the necessity for this workshop due to the fact that the participants of the Graphene Flagship rather try to avoid formal standardization due to complexity and time-consuming processes. Accordingly, the Graphene Flagship is aware of the general benefits of standardization but struggle with the formal aspects. However, the intention of the workshop is to propose the development of formal standards at IEC based on the CWAs published. This is ensured as the proposed workshop chairperson is secretary of IEC/TC 113. It is expected that accompanied with the development of a number of CWAs the worth and effectiveness of the global standardization organizations will be obvious within the Flagship and will help to bridge the gap between the research and the standardization community.

### **3. Workshop proposers and Workshop participants**

Original proposers of the Workshop:

- KIT, Germany: Karlsruhe Institute of Technology, Dr. Norbert Fabricius (Secretary of IEC/TC 113)

Initial members of the Workshop: see Annex A

Registered participants having approved the current Business Plan (preferably through linking to an Annex; NOTE: After Kick-off meeting): tbd.

#### **4. Workshop scope and objectives**

The workshop intends to disseminate research results achieved within the Graphene Flagship. Even though IEC/TC 113 deals with the characterization or specification of GRM we see the necessity for this workshop due to the fact that the participants of the Graphene Flagship rather try to avoid formal standardization due to complexity and time-consuming processes. Accordingly, the Graphene Flagship is aware of the general benefits of standardization but struggle with the technical aspects. However, the intention of the workshop is to propose the development of formal standards at IEC based on the CWAs published.

At the current state of the Graphene Flagship there is no fixed work programme on standardization. It is obvious for the attendees that the most needed standards are material standards which help to define and identify materials because graphene is only a synonym for a large variety of materials. Therefore, the standardization of a graphene related terminology is highly requested.

In the first phase the workshop will identify the five most important Key Control Characteristics (KCC) of graphene and list them in a Blank Detail Specification.

Terminology aspects appearing during the definition of those KCCs will be discussed and harmonized with the ongoing project IEC/TS 80004-13.

The measurement methods for those KCCs will be discussed and documented in CWAs. Whenever a link to relevant IEC Technical committees is required the information will be exchanged between the Workshop and the IEC Technical Committees. The broad research community within the Graphene Flagship offers the opportunity that comparable measurement can be performed to qualify measurement methods.

However the timescale is well defined because significant results are requested within the first 18 months starting October 2014. Those results are deliverables within the Graphene Flagship which is a strong motivation for all committed members of the Graphene Flagship Consortium.

## 5. Workshop programme

The CWAs will be drafted and published in English.

### Work plan

It needs to be noted that at this point in time only a generic work programme can be formulated. Nevertheless as an ongoing process the work programme will be concretized. Within the timeframe of 18 months starting October 2014 the following work programme will be performed:

- CWA 1 "Material specifications – Graphene related materials – Blank detail specification".
- CWA 2 "Key control characteristics – Graphene related materials – Key control characteristic 1"
- CWA 3 "Key control characteristics – Graphene related materials – Key control characteristic 2"
- CWA 4 "Key control characteristics – Graphene related materials – Key control characteristic 3"
- CWA 5 "Key control characteristics – Graphene related materials – Key control characteristic 4"
- CWA 6 "Key control characteristics – Graphene related materials – Key control characteristic 5"

CWA 2 to CWA 6 are referring to the five most important key control characteristics which are not yet identified. They will be selected out of an existing list during the kick-off meeting. The business plan will be updated accordingly.

## 6. Workshop structure

The secretariat is run by the German CENELEC member DKE German Commission for Electrical, Electronic & Information Technologies of DIN and VDE. DKE as a neutral platform manages standardization for several decades and has a profound knowledge and adequate tools for arranging meetings as well as for the document management.

The dedicated chairperson is the secretary of IEC/TC 113. This ensures proper harmonization with the work of the relevant IEC Technical Committees.

As the deliveries needs to be specified in the first three months of the workshop there is no final structure defined currently. Nevertheless it is obvious that we will have a dedicated project team for each CWA under consideration.

## 7. Resource requirements

All costs related to the participation of interested parties in the Workshop's activities have to be borne by themselves. However, there will be no fee for registered participants in the Workshop as long as the number of registered participants does not exceed 20. If this is the case, the workshop secretary might set a fee for all participants to cover extra costs related to the size of the workshop (e.g. special meeting rooms).

## 8. Related activities, liaisons, etc.

It is not intended to set up liaisons within the workshop. However, the link to IEC/TC 113 is ensured by the chairman. Moreover, IEC/TC 113 has formal liaisons with other related standardization committees (ISO/TC 229 Nanotechnology; IEC/TC 119 Printed Electronics) so that all aspects of the Graphene Flagship should be covered. The workshop is open to other R&D organizations which might provide valuable input. However, the Graphene Flagship consists of 76 academic and industrial research groups from 17 European countries (more details see [http://graphene-flagship.eu/?page\\_id=68](http://graphene-flagship.eu/?page_id=68)) so that a broad and exhaustive input into the workshop is ensured.

## 9. Contact points

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## Annexes

### Annex A: Initial members of the workshop

#### Attendees to the CLC WS Graphene kickoff meeting.

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