

# Graphene Standardization: Key Success Factor for Graphene Industrialization

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## Abstract

Since its discovery, graphene and other 2D materials have been the subject of intensive research worldwide. Naturally, for such a promising new material, a large number of start-up companies have entered the market to manufacture and supply graphene in consistent quality for commercialization of graphene-enabled products. However, due to missing international standards for characterization of graphene materials, the use of graphene related materials in an industrial environment is slowed down significantly.

Therefore, IEC and ISO have started standardization projects for graphene materials, most of them allocated to the IEC Technical Committee 113. Currently there are only two standards published yet, one on terminology (ISO 80004-13) and one defining a method to measure sheet resistance (IEC 62607-6-4). However, driven by industry, many standards are under development. The last count after the IEC/TC 113 Plenary Meeting in Shenzhen, China gave 32 standards under development. In this process, IEC TC 113 is following a strategy which is based on quality management (QM) principles [1] to develop standards which directly support industrialization.

More specifically, the QM-strategy is centred on two pivotal document types:

- 1) The technical specification for materials, which provide a standardized format to specify the quality-relevant material characteristics and other information relevant for procurement.
- 2) Specification for characterization techniques for Key Control Characteristics (KCCs).

These standards will build the basis for statistical process control in fabrication of graphene-based products as well as the procurement in the international supply chain.

In this contribution an overview regarding the landscape of graphene standardization will be given to provide a comprehensive overview of international activities. Furthermore the electrical characterization of graphene layers by and structural characterization of graphene will be discussed in detail.

Figure 1 shows the leadership of the standardization projects by country and underscores the international character of graphene and 2D material standardization.

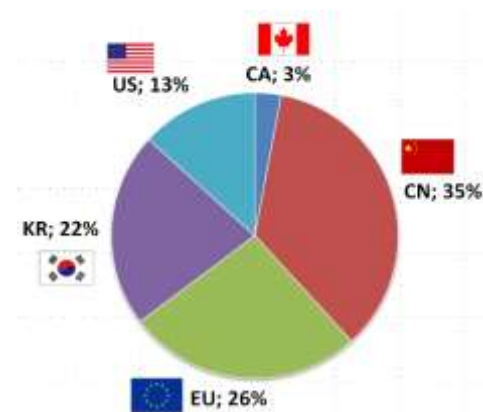
## Acknowledgement

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## References

- [1] J. Wittmann and W. Bergholz, "Introduction to Quality Management in the Semiconductor Industry – Vol. 1 General" ISBN-10: 1535046341 (printed version) 2nd Ed., Oct 26th,

## Figures



**Figure 1:** Project leadership in IEC/TC 113 regarding graphene standardization worldwide (Total: 34 Standards under development; status 11/2017)