BSI Standards Publication

Nanomanufacturing — Key control characteristics

Part 6-3: Graphene-based material — Domain size: substrate oxidation

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National foreword

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The UK participation in its preparation was entrusted to Technical Committee NTI/1, Nanotechnologies.

A list of organizations represented on this committee can be obtained on request to its committee manager.

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Nanomanufacturing – Key control characteristics – Part 6-3: Graphene-based material – Domain size: substrate oxidation

INTERNATIONAL ELECTROTECHNICAL COMMISSION

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FOREWORD

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Technical Specifications are subject to review within three years of publication to decide whether they can be transformed into International Standards.

IEC TS 62607-6-3, which is a Technical Specification, has been prepared by technical committee 113, Nanotechnology for electrotechnical products and systems.

The text of this Technical Specification is based on the following documents:

Enquiry draft	Report on voting
113/496/DTS	113/549/RVDTS

Full information on the voting for the approval of this Technical Specification can be found in the report on voting indicated in the above table.

This document has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all parts in the IEC TS 62607 series, published under the general title *Nanomanufacturing – Key control characteristics*, can be found on the IEC website.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under "http://webstore.iec.ch" in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

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INTRODUCTION

Graphene with two-dimensional honeycomb structures of carbon atoms is known to have exceptional electrical, thermal, and mechanical properties. Because of these properties, graphene is considered for applications in high speed, flexible and transparent devices. Figure 1 shows the images of graphene field effect transistor, flexible touch screen in display, and transparent electrode in solar cell. These applications of graphene are promising candidates for nanoelectronics and optoelectronics. Graphene has been widely investigated by researchers from academic institutions, research institutes, and industries.

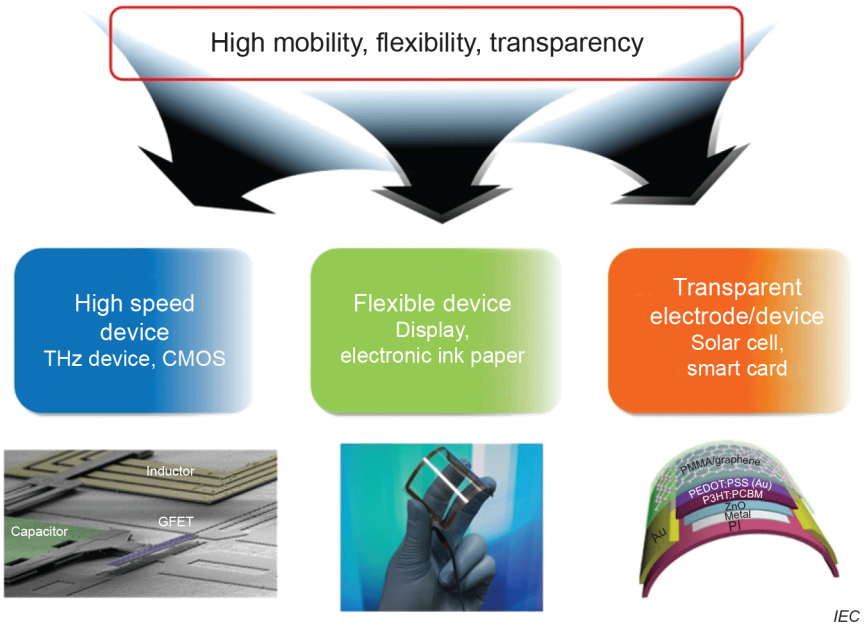

Figure 1 – Applications of graphene

Graphene synthesized on Cu or Ni substrate by chemical vapour deposition (CVD) is composed of graphene domains formed during the nucleation and initial growth stage. Graphene defects, such as pinholes, domain boundaries, and cracks, can be formed during the CVD growth or the transfer process.

Properties of graphene are related to the size and distribution of graphene domains and defects. As graphene domain size is increased and graphene defects are reduced, electrical and thermal properties of graphene are improved.

Graphene domains and defects are usually observed by atomic force microscopy (AFM), scanning electron microscopy (SEM), transmission electron microscopy (TEM), Raman spectroscopy, and scanning tunnelling microscopy (STM). These analysis methods may cause inconvenience in preparing a sample for analysis and require very expensive equipment that provides only local information of several micrometres and below.

Facile, fast, reliable methods of evaluating graphene domains have not yet been established and urgently need to be developed.

NANOMANUFACTURING – KEY CONTROL CHARACTERISTICS –

Part 6-3: Graphene-based material – Domain size: substrate oxidation

1 Scope

This part of IEC TS 62607 establishes a standardized method to determine the structural key control characteristic

– domain size

for films consisting of graphene grown by chemical vapour deposition (CVD) on copper by

– substrate oxidation.

It provides a fast, facile and reliable method to evaluate graphene domains formed on copper foil or copper film for understanding the effect of the graphene domain size on properties of graphene and enhancing the performance of high speed, flexible, and transparent devices using CVD graphene.

– The domain size determined in accordance with this document will be listed as a key control characteristic in the blank detail specification for graphene IEC 62565-3-1. Domain density is an equivalent measure.
– The domain size as derived by this method is defined as the mean value of size of the domains in the observed area specified by supplier in terms of cm^2 or μm^2.
– The method is applicable for graphene grown on copper by CVD. The characterization is done on the copper foil before transfer to the final substrate.
– As the method is destructive, the samples cannot be re-launched into the fabrication process.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ASTM E1951-14, *Standard Guide for Calibrating Reticles and Light Microscope Magnification*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp