
Nanotehnologije - Slovar - 13. del: Grafen in sorodni dvodimenzionalni (2D) materiali (ISO/TS 80004-13:2017)

Nanotechnologies - Vocabulary - Part 13: Graphene and related two-dimensional (2D) materials (ISO/TS 80004-13:2017)

Nanotechnologien - Fachwörterverzeichnis - Teil 13: Graphen und andere zweidimensionale (2D) Werkstoffe (ISO/TS 80004-13:2017)

Nanotechnologies - Vocabulaire - Partie 13: Graphene et autres matériaux bidimensionnels (ISO/TS 80004-13:2017)

<https://standards.iteh.ai/catalog/standards/sist/07379453-981e-495c-96d8-2b8f8232971/sist-ts-cen-iso-ts-80004-13-2020>

Ta slovenski standard je istoveten z: CEN ISO/TS 80004-13:2020

ICS:

01.040.07	Naravoslovne in uporabne vede (Slovarji)	Natural and applied sciences (Vocabularies)
07.120	Nanotehnologije	Nanotechnologies

SIST-TS CEN ISO/TS 80004-13:2020 **en,fr,de**

iTeh STANDARD PREVIEW
(standards.iteh.ai)

[SIST-TS CEN ISO/TS 80004-13:2020](#)

<https://standards.iteh.ai/catalog/standards/sist/07379453-981e-495c-96d8-2bffe833971/sist-ts-cen-iso-ts-80004-13-2020>

TECHNICAL SPECIFICATION
SPÉCIFICATION TECHNIQUE
TECHNISCHE SPEZIFIKATION

CEN ISO/TS 80004-13

August 2020

ICS 07.120; 01.040.07

English Version

**Nanotechnologies - Vocabulary - Part 13: Graphene and
related two-dimensional (2D) materials (ISO/TS 80004-
13:2017)**

Nanotechnologies - Vocabulaire - Partie 13: Graphène
et autres matériaux bidimensionnels (ISO/TS 80004-
13:2017)

Nanotechnologien - Fachwörterverzeichnis - Teil 13:
Graphen und andere zweidimensionale (2D)
Werkstoffe (ISO/TS 80004-13:2017)

This Technical Specification (CEN/TS) was approved by CEN on 10 August 2020 for provisional application.

The period of validity of this CEN/TS is limited initially to three years. After two years the members of CEN will be requested to submit their comments, particularly on the question whether the CEN/TS can be converted into a European Standard.

CEN members are required to announce the existence of this CEN/TS in the same way as for an EN and to make the CEN/TS available promptly at national level in an appropriate form. It is permissible to keep conflicting national standards in force (in parallel to the CEN/TS) until the final decision about the possible conversion of the CEN/TS into an EN is reached.

CEN members are the national standards bodies of Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Republic of North Macedonia, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and United Kingdom.

<https://standards.iteh.ai/catalog/standards/sist/07379453-981e-495c-96d8-2bffe833971/sist-ts-cen-iso-ts-80004-13-2020>



EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

CEN-CENELEC Management Centre: Rue de la Science 23, B-1040 Brussels

Contents	Page
European foreword.....	3

iTeh STANDARD PREVIEW
(standards.iteh.ai)

SIST-TS CEN ISO/TS 80004-13:2020
<https://standards.iteh.ai/catalog/standards/sist/07379453-981e-495c-96d8-2bffe833971/sist-ts-cen-iso-ts-80004-13-2020>

European foreword

The text of ISO/TS 80004-13:2017 has been prepared by Technical Committee ISO/TC 229 "Nanotechnologies" of the International Organization for Standardization (ISO) and has been taken over as CEN ISO/TS 80004-13:2020 by Technical Committee CEN/TC 352 "Nanotechnologies" the secretariat of which is held by AFNOR.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN shall not be held responsible for identifying any or all such patent rights.

According to the CEN-CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this Technical Specification: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Republic of North Macedonia, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

Endorsement notice

The text of ISO/TS 80004-13:2017 has been approved by CEN as CEN ISO/TS 80004-13:2020 without any modification.

iTeh STANDARD PREVIEW
(standards.iteh.ai)

[SIST-TS CEN ISO/TS 80004-13:2020](https://standards.iteh.ai/catalog/standards/sist/07379453-981e-495c-96d8-2bffe833971/sist-ts-cen-iso-ts-80004-13-2020)
<https://standards.iteh.ai/catalog/standards/sist/07379453-981e-495c-96d8-2bffe833971/sist-ts-cen-iso-ts-80004-13-2020>

iTeh STANDARD PREVIEW
(standards.iteh.ai)

[SIST-TS CEN ISO/TS 80004-13:2020](#)

<https://standards.iteh.ai/catalog/standards/sist/07379453-981e-495c-96d8-2bffe833971/sist-ts-cen-iso-ts-80004-13-2020>

TECHNICAL
SPECIFICATION

ISO/TS
80004-13

First edition
2017-09

**Nanotechnologies — Vocabulary —
Part 13:
Graphene and related two-
dimensional (2D) materials**

Nanotechnologies — Vocabulaire —

Partie 13: Graphène et autres matériaux bidimensionnels

**iTeh STANDARD PREVIEW
(standards.iteh.ai)**

[SIST-TS CEN ISO/TS 80004-13:2020](https://standards.iteh.ai/catalog/standards/sist/07379453-981e-495c-96d8-2bffe833971/sist-ts-cen-iso-ts-80004-13-2020)

<https://standards.iteh.ai/catalog/standards/sist/07379453-981e-495c-96d8-2bffe833971/sist-ts-cen-iso-ts-80004-13-2020>



Reference number
ISO/TS 80004-13:2017(E)

© ISO 2017

iTeh STANDARD PREVIEW
(standards.iteh.ai)

SIST-TS CEN ISO/TS 80004-13:2020
<https://standards.iteh.ai/catalog/standards/sist/07379453-981e-495c-96d8-2bffe833971/sist-ts-cen-iso-ts-80004-13-2020>



COPYRIGHT PROTECTED DOCUMENT

© ISO 2017, Published in Switzerland

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized otherwise in any form or by any means, electronic or mechanical, including photocopying, or posting on the internet or an intranet, without prior written permission. Permission can be requested from either ISO at the address below or ISO's member body in the country of the requester.

ISO copyright office
Ch. de Blandonnet 8 • CP 401
CH-1214 Vernier, Geneva, Switzerland
Tel. +41 22 749 01 11
Fax +41 22 749 09 47
copyright@iso.org
www.iso.org

Contents

Page

Foreword	iv
Introduction	v
1 Scope	1
2 Normative references	1
3 Terms and definitions	1
3.1 Terms related to materials.....	1
3.1.1 General terms related to 2D materials.....	1
3.1.2 Terms related to graphene.....	3
3.1.3 Terms related to other 2D materials.....	5
3.2 Terms related to methods for producing 2D materials.....	5
3.2.1 Graphene and related 2D material production.....	5
3.2.2 Nanoribbon production.....	8
3.3 Terms related to methods for characterizing 2D materials.....	8
3.3.1 Structural characterization methods.....	8
3.3.2 Chemical characterization methods.....	10
3.3.3 Electrical characterization methods.....	12
3.4 Terms related to 2D materials characteristics.....	13
3.4.1 Characteristics and terms related to structural and dimensional properties of 2D materials.....	13
3.4.2 Characteristics and terms related to chemical properties of 2D materials.....	15
3.4.3 Characteristics and terms related to optical and electrical properties of 2D materials.....	16
4 Abbreviated terms	16
Bibliography	17
Index	18

ISO/TS 80004-13:2017(E)

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

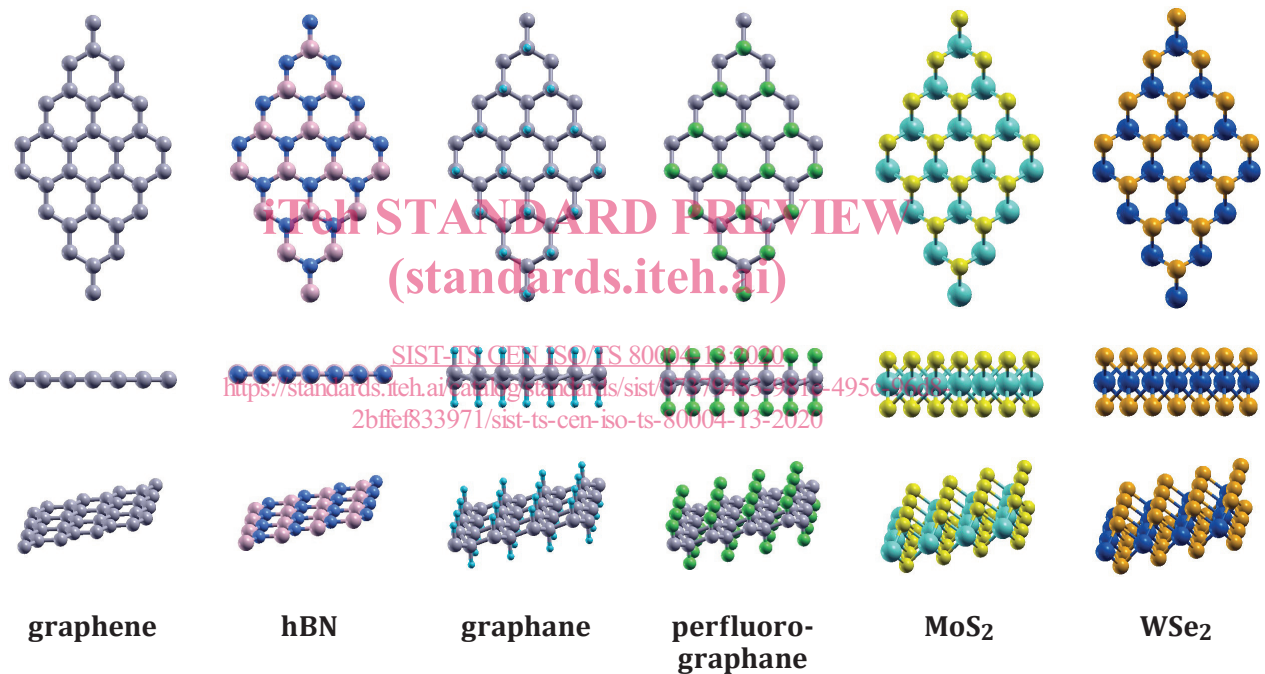
For an explanation on the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html. (standards.iteh.ai)

This document was prepared by Technical Committee ISO/TC 229, *Nanotechnologies*, and IEC/TC 113, *Nanotechnology for electrotechnical products and systems*.

A list of all parts in the ISO 80004 series can be found on the ISO website.

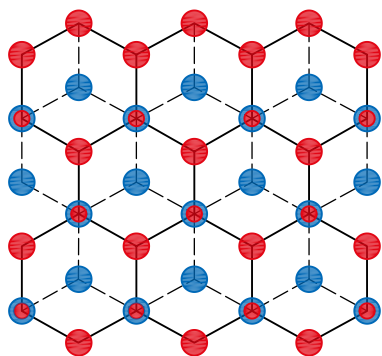
Introduction

Over the last decade, huge interest has arisen in graphene both scientifically and commercially, due to the many exceptional properties associated with this material, properties such as the electrical and thermal conductivity. More recently, other materials with a structure similar to that of graphene have also shown promising properties including monolayer and few-layer versions of hexagonal boron nitride (hBN), molybdenum disulphide (MoS_2), tungsten diselenide (WSe_2), silicene and germanene and layered assemblies of mixtures of these materials. These materials have their thickness constrained within the nanoscale or smaller and consist of between one and several layers. These materials are thus termed two-dimensional (2D) materials as they have one dimension at the nanoscale or smaller, with the other two dimensions generally at scales larger than the nanoscale. A layered material consists of two-dimensional layers weakly stacked or bound to form three-dimensional structures. Examples of 2D materials and the different stacking configurations in graphene are shown in [Figure 1](#). It should be noted that 2D materials are not necessarily topographically flat in reality and can have a buckled structure. They can also form aggregates and agglomerates which can have different morphologies. Two-dimensional materials are an important subset of nanomaterials.

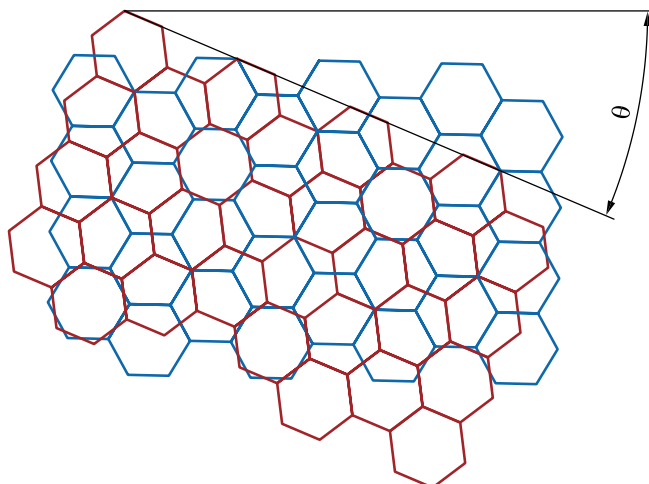
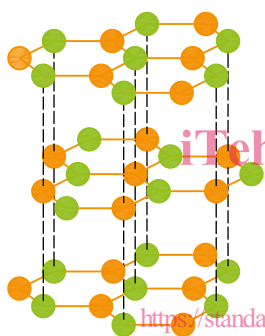


a) Examples of different two-dimensional materials consisting of different elements and structures, as shown by the different coloured orbs and top-down and side views

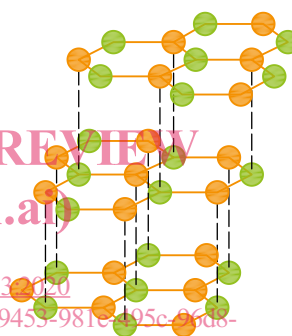
ISO/TS 80004-13:2017(E)



b) Bernal stacked bilayer graphene (3.1.2.6)

c) turbostratic bilayer or twisted bilayer graphene with relative stacking angle, θ , (3.1.2.7)

ABA trilayer



ABC trilayer

d) Bernal stacked (AB) (3.4.1.10) tri-layer graphene (3.1.2.9) and Rhombohedral (ABC) (3.4.1.11) stacked tri-layer graphene (3.1.2.9)

Figure 1 — Examples of 2D materials and the different stacking configurations in graphene layers

It is important to standardize the terminology for graphene, graphene-derived and related 2D materials at the international level, as the number of publications, patents and organizations is increasing rapidly. Thus, these materials need an associated vocabulary as they become commercialized and sold throughout the world.

This document belongs to a multi-part vocabulary covering the different aspects of nanotechnologies. It builds upon ISO/TS 80004-3, ISO/TS 80004-11 and ISO/TS 80004-6 and uses existing definitions where possible.