

<b>STN P</b>	<b>Nanotechnológie Slovník Časť 13: Grafén a príbuzné dvojrozmerné (2D) materiály (ISO/TS 80004-13: 2017)</b>	<b>STN P CEN ISO/TS 80004-13</b>  60 3030
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Nanotechnologies - Vocabulary - Part 13: Graphene and related two-dimensional (2D) materials (ISO/TS 80004-13:2017)

Táto norma obsahuje anglickú verziu európskej normy.  
This standard includes the English version of the European Standard.

Táto norma bola oznámená vo Vestníku ÚNMS SR č. 11/20

Táto predbežná STN je určená na overenie. Pripomienky zasielajte ÚNMS SR najneskôr do 31. 7. 2022.

Obsahuje: CEN ISO/TS 80004-13:2020, ISO/TS 80004-13:2017

**131941**

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)

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<b>Contents</b>	<b>Page</b>
<b>European foreword.....</b>	<b>3</b>

## **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.

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## **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.

**TECHNICAL  
SPECIFICATION**

**ISO/TS  
80004-13**

First edition  
2017-09

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

*Nanotechnologies — Vocabulaire —*

*Partie 13: Graphène et autres matériaux bidimensionnels*



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

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# Contents

Page

<b>Foreword</b> .....	<b>iv</b>
<b>Introduction</b> .....	<b>v</b>
<b>1 Scope</b> .....	<b>1</b>
<b>2 Normative references</b> .....	<b>1</b>
<b>3 Terms and definitions</b> .....	<b>1</b>
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
<b>4 Abbreviated terms</b> .....	<b>16</b>
<b>Bibliography</b> .....	<b>17</b>
<b>Index</b> .....	<b>18</b>

**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](http://www.iso.org/directives)).

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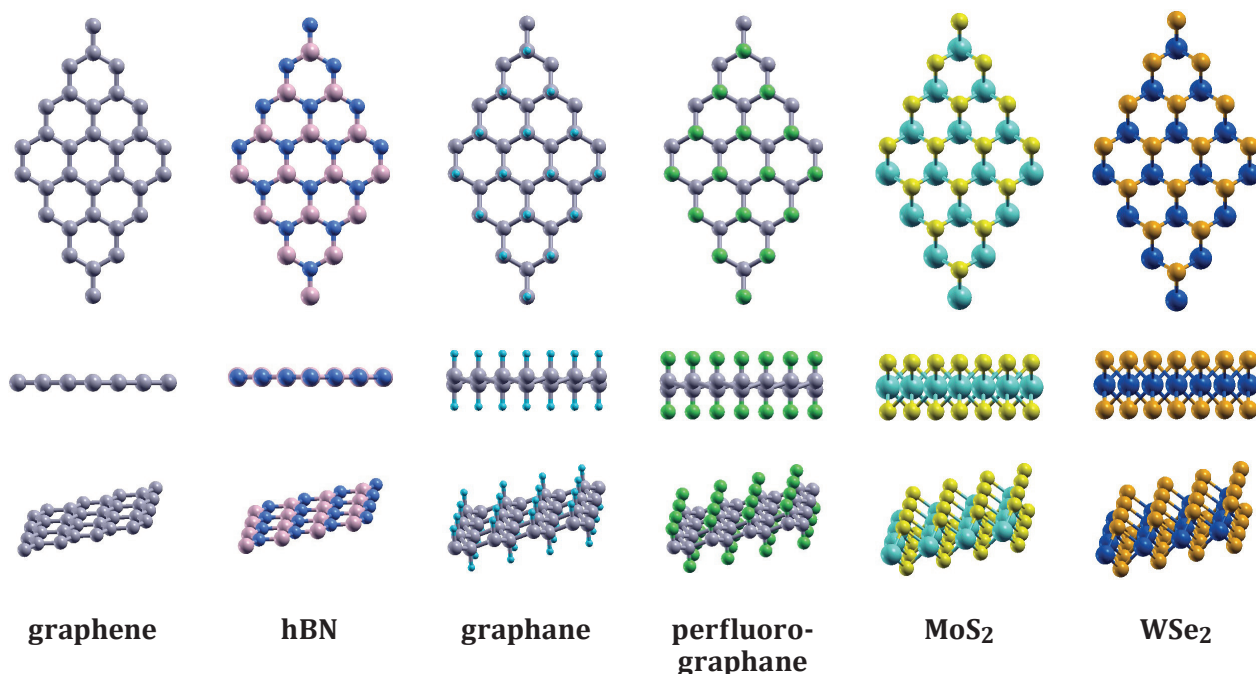
This document was prepared by Technical Committee ISO/TC 229, *Nanotechnologies*, and IEC/TC 113, *Nanotechnology for electrotechnical products and systems*.

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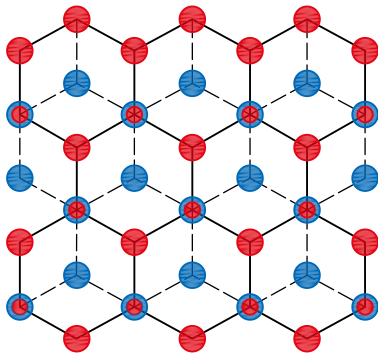
## Introduction

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 ( $\text{MoS}_2$ ), tungsten diselenide ( $\text{WSe}_2$ ), 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.

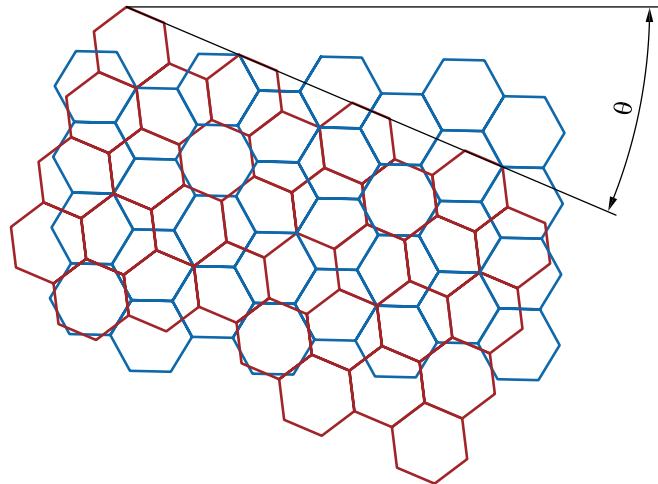
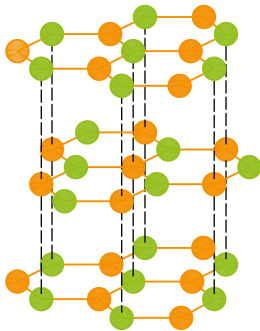


a) Examples of different two-dimensional materials consisting of different elements and structures, as shown by the different coloured orbs and top-down and side views

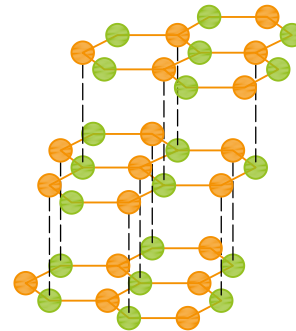
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b) Bernal stacked bilayer graphene (3.1.2.6)

c) turbostratic bilayer or twisted bilayer graphene with relative stacking angle,  $\theta$ , (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.

# **Nanotechnologies — Vocabulary —**

## **Part 13:**

# **Graphene and related two-dimensional (2D) materials**

## **1 Scope**

This document lists terms and definitions for graphene and related two-dimensional (2D) materials, and includes related terms naming production methods, properties and their characterization.

It is intended to facilitate communication between organizations and individuals in research, industry and other interested parties and those who interact with them.

## **2 Normative references**

There are no normative references in this document.

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