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No. 104

Advanced Materials: Working Description

IOMC
INTER-ORGANIZATION PROGRAMME FOR THE SOUND MANAGEMENT OF CHEMICALS
A cooperative agreement among **FAO, ILO, UNDP, UNEP, UNIDO, UNITAR, WHO, World Bank and OECD**

Environment Directorate
ORGANISATION FOR ECONOMIC COOPERATION AND DEVELOPMENT
Paris 2022

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or contact:

OECD Environment Directorate,

Environment, Health and Safety Division

2 rue André-Pascal

75775 Paris Cedex 16

France

Fax: (33-1) 44 30 61 80

E-mail: ehscont@oecd.org

1. Foreword

1. The OECD's Working Party on Manufactured Nanomaterials (hereafter WPMN) has been addressing human and environmental risks of nanomaterials since 2006. Over the years, it became more and more evident that governmental considerations on new materials should not be limited to the 'simple' nanomaterials. Furthermore, many of these (nano) materials possess/display an additional complexity, e.g. a new or enhanced functionality and/or multiple components. This may lead to further challenges compared to 'simple' nanomaterials. They are a part of a broader material group: so-called "advanced materials" (hereafter AdMa).

2. For some of these materials, similar or additional challenges to those identified for nanomaterials can be expected in the framework of chemical safety. The potential risk of these materials could be determined by physical properties besides chemical composition. The WPMN also recognised that AdMa bear great potential for different sectors such as renewable energy, e-mobility, digitalisation, health care or efficient use/saving of resources. Thus, AdMa and innovative manufacturing processes are in the focus of innovation research, with anticipated benefits for the economy, the society and the environment.

3. Based on the long-lasting work of the WPMN concerning safety of nanomaterials, materials with a nano-component are the starting point for addressing advanced materials. Therefore, the emphasis of the present work will be on AdMa that contain a nanomaterial or materials having a nanostructure. Nevertheless, the delegates recognised a need not to limit the scope to the nanoscale in order to describe the playing field of advanced materials relevant to the WPMN.

4. Recognising the term "advanced materials" (AdMa) is used broadly and in different contexts, the WPMN decided to focus on the linkages between nanotechnologies and AdMa, and start to build a common understanding on the playing field of the term for its use by the WPMN.

5. With this in mind, the WPMN collected the views of OECD Delegations via a questionnaire (see Annex), and reviewed the findings from previous efforts in this area (e.g. Advanced Materials - Thematic Conferences led by Germany)[1]. The results from the questionnaire led to the development of a ***Working Description on Advanced Materials*** (WD AdMa) that should provide a framework for the work of the WPMN.

[1] https://www.umweltbundesamt.de/en/service/dates/advanced-materials-3rd-thematic-conference

OECD Working Party on Manufactured Nanomaterials' Working Description on Advanced Materials

Advanced Materials: Working Description

I. The ***Working Party on Manufactured Nanomaterials' (WPMN) Working Description on Advanced Materials*** aims to illustrate the content of the Advanced Materials playing field and the purpose of WPMN's engagement regarding these materials[2].

II. In this context, AdMa are understood as materials that are rationally designed to have

- new or enhanced properties, and/or
- targeted or enhanced structural features

with the objective to achieve specific or improved functional performance3. This includes both new emerging manufactured materials, and materials that are manufactured from traditional materials. This also includes materials from innovative manufacturing processes that enable the creation of targeted structures from starting materials, such as bottom-up approaches. It is acknowledged that what are currently considered as AdMa will change with time.

III. The considerations within the WPMN will build on the knowledge gained on manufactured nanomaterials, and possibly include other AdMa with relevance to safety, sustainability and regulatory issues considering their whole life cycle. Advanced Materials under consideration of WPMN are aimed to be assessed in order to improve their safety, sustainability and regulatory coverage within the strategic approach to identify knowledge gaps and recommendations for action. The AdMa in focus will evolve as additional knowledge is gained and appropriate strategies are developed.

IV. Examples of possible cases of AdMa that could be considered are given in the Annex.

[2] The WPMN does not intend to develop a definition for AdMa. It is noted that ISO is working on a definition of advanced materials.

[3] Other synonyms are conceivable for the terms "manufactured", "enhanced", "targeted", "rationally designed" or "improved" like "specifically engineered", "superior", "novel".

Annex A. Examples of Advanced Materials

6. This annex presents the results of the WPMN questionnaire on Advanced Materials, which was circulated in October-November 2021 to OECD Delegations. The purpose was to get an indication about delegations' views on the term "***advanced materials***", and to identify areas of common interest. The results were also served as the basis for defining the WPMN playing field in addressing Advanced Materials. Responses were given by experts from the following delegations: Canada, Germany, Italy, Japan, Spain, Switzerland, United Kingdom, Thailand, the European Commission, and BIAC.

1. Does your country/organisation/institution have a description on the term advanced materials?

a. In case, please provide the description

EU	• In the area of research and development and the corresponding funding systems of the European Commission, advanced materials generally mean materials that have novel or enhanced properties that improve performance over conventional products and processes. Source: https://research-and-innovation.ec.europa.eu/research-area/industrial-research-and-innovation/key-enabling-technologies/advanced-materials-and-chemicals_en • It should be noted that the European Commission does not have a formal definition of the term "Advanced Material".
Germany	Working description of the German interagency working group: *Advanced materials are materials that are rationally designed through the precise control of their composition and/or internal and/or external structure in order to fulfil the functional requirements of a certain application.* (might be changed at later stage in case revision is deemed needed)

b. If not, please provide input to the key aspects of the term advanced materials

Canada	• Canada does not have a regulatory or working description of advanced materials. • There is no regulatory or working definition for advanced materials in Canada. We recently conducted a review of the definitions proposed by several Canadian stakeholders. None of the proposed definitions are adopted nationally, but they raise some key aspects to be considered. Most stakeholders' definitions consider physical and functional performance, and some target engineering and timeframe considerations. From a regulator's point of view, considerations of the timeframe or "novelty" of advanced materials are very inconvenient, and we hope a future definition will not continue on such path. • Our preferred preliminary working definition for advanced materials consider the functionality and the performance advantage of these substances. We do not have strong preference at this point about the necessity to have engineering considerations in a future definition, for example by the expression of transformation through manufacturing process.
EU	• Advanced Materials are innovative materials • The status of 'advanced material' is temporary: over time, advanced materials become conventional, making place for other more advanced materials
Italy	Materials with new properties, functionality, structures in 2 or 3 dimensions, and/or from advanced manufacturing /technologies
Japan	I think that the term "advanced materials" or related terms are used arbitrarily without definite descriptions in Japan. They seem to represent that the materials are expected to show novel and/or excellent functions due to their new structure and/or composition.
Spain	• Considering a focus on manufactured nanomaterials (MN) our institution (INIA, CSIC) is working on the idea that Advanced Materials (AdMa) are complex materials (multicomponent materials or materials with several elements in their composition) in the nano-size (it will be necessary to establish size thresholds, but maybe we could talk about at least one dimension below 100 nm) with targeted structures. • Since they have been generated due to technological advances from the last years they can be considered as new materials, with unknown safety for human beings and the environment.
Switzerland	Material that has a new function that differs from the functions of the individual components and/or the bulk materials (in the case of NM) of the individual components. Materials that have been developed with the aim of exhibiting this function. We consider primarily manufactured materials as relevant, not naturally occurring materials.
Thailand	Materials with special (specific) function and properties. Design for special purpose and not found in natural.
United Kingdom	Advanced materials should exhibit enhanced properties that are generated by either the combination (composition) and/ or the form (e.g. size, shape) of the components within the combination and/ or the orientation of the different components in relation to each other (e.g. core-shell, or fibre matrix with attached particles).
United Kingdom	• Within the UK definitions and descriptions of material categories used typically depend on the area of work addressed and the purpose of the definition and thus may vary with Gov Dept/Institution etc. Up to recently, there has been no single description or definition of advanced materials used across the UK although the term has been used for over a decade to cover significant new developments in materials science, in particular in relation to research and innovation funding. • However, in 2020, the UK Government consulted UK stakeholders on proposed descriptions of activities of qualifying entities within 17 sectors including Advanced Materials and the responses from this consultation have been used to refine draft definitions. The draft definitions, including the definition for Advanced Materials, can be found in a report published by the Department of Business, Energy and Industrial Strategy (BEIS). This report is publically available and the definition can found in Annex A: National Security and Investment: Sectors in Scope of the Mandatory Regime Government Response to. the consultation on mandatory notification in specific sectors under the National Security and Investment Bill. March 2021. This report is publically available and can be found at the following address: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/965784/nsi-scope-of-mandatory-regime-gov-response.pdf • A version of this definition, shown below, has been included in draft regulations under the National Security and Investment Act which comes into force in 2022. (e.g. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1003506/Draft_National_Security_and_Investment_Act_2021__Notifiable_Acquisition__Specification_of_Entities__Regulations_2021.pdf)

	"advanced materials" means completely new materials and materials that are developments on traditional materials, where such materials provide any of the following— *(a) targeted properties;* *(b) advantageous properties;* *(c) outstanding structural properties; or* *(d) outstanding functional properties;* • These regulations also identify some specific advanced material categories, including: Advanced composites, Metals and Alloys, Engineering and technical polymers, Engineering and technical ceramics, Technical textiles, Metamaterials, Semiconductors, Photonic and optoelectronic materials and devices, Graphene and related 2D materials, and Nanotechnology. The regulations include very detailed definitions of each category with some indications of what should not be considered. • However, note that (1) This is a draft definition and may be subject to change (2) the regulatory regime this relates to is **not** health and safety related but related to investment/security (3) more detailed descriptions under the categories relate strongly to the types of advanced manufacturing techniques used to produce the materials
BIAC	• Advanced Materials are materials related to, and often enable, advanced or emerging technologies. Typically, advanced materials are under continual development within organizations to exceed the performance of conventional materials in one or more areas. Materials that are considered "conventional" will change with time as technology develops, as will the "advanced" status of other materials. • In academia, advanced materials are typically referred to materials having favourable engineered properties for envisioned applications.
BIAC(NIA)	Materials having properties and/or functions that are not possible to achieve following historically traditional methods for producing, preparing, or processing.

2. Does your country/organisation/institution have criteria for

a) What is considered to be an advanced material? In case, please provide.

Canada	Canada does not yet have a set of criteria for what is considered an advanced material.
EU	• As stated, advanced materials are effectively innovative materials. • Advanced materials can introduce new functionalities and improved properties, while adding value to existing products and processes, in a sustainable approach (from Horizon Europe). • They can boost the transition to greener technologies, with improved characteristics and enhanced performance, contributing to a more sustainable future. People benefit from new products, or novel health applications, and from reduced environmental impacts. Advanced materials also provide a competitive edge to industry and to the economy as a whole, creating jobs. • There should be no further attempt to restrict Advanced Materials to particular subclass(es) of materials. Concrete subclass(es) of materials should be designated as 'advanced', pending a light but transparent process in WPMN and may diverge from the use of the term in different regions. Some members of the subclass might in some circles already be considered as being ‚conventional'. However, one or more specific advanced, 'novel' feature(s) should be common to that subclass. See e.g. nanomaterials. • Due to its very nature, the status as 'advanced materials' as compared to 'conventional materials' is likely to expire in time. As the timescale is assumed at least 10 years, this should not be an issue for the envisioned WPMN tasks that are expected to either conclude in the timeframe or pass the subclass to an appropriate longer-term process within the chemicals programme. • A conventional material or class of materials for which no qualitative changes in the manufacturing, use or features in recent years have been taken place. For such materials adequate tools are available to safely manage their use and continuous improvement.
Germany	For now, criteria for advanced materials are not available but discussion are ongoing that includes e.g. functionality, novelty, structure, and composition.
Italy	No specific criteria have been defined yet, discussion is ongoing.
Japan	Not aware of any criteria.
Spain	These criteria are similar to the key aspects mentioned above.
United Kingdom	Please see answer to previous question. A long list is provided in Annex A of the BEIS report.
BIAC	Currently, there are no specific criterial for identifying advanced materials. Interpretations are often varied. Organizations such as ISO TC 229 are working to clarify common aspects and interpretations that may assist in this area.

b) What is considered not to be an advanced material? In case, please provide

EU	(1) The term "Advanced Materials" implies a temporal meaning ("novel or enhanced properties that improve performance") and this makes it more difficult to define than e.g. "nanomaterials". The latter can be classified based on measurable physical criteria. A NM will remain a NM until the material itself changes. On the contrary, an AdMa today most likely will not be an AdMa tomorrow. What was an AdMa yesterday (e.g. semiconductor junctions in the 1960's) can hardly be considered an AdMa today. I think the playing field should also include a temporal component, and maybe the WPMN could work towards a more tangible temporal component (better than just "new" and "improved") to be one dimension of the playing field. (2) To be an advanced material it is probably not enough to belong to a specific class of materials such as those listed in question 3. Such materials are characterised by their composition or structure, but from this we cannot judge a priori whether they are advanced or not because one needs to consider a certain function or application. If such a material exhibits a novel, innovative or improved function only then it should be considered as advanced.
Germany	Classic, non-new and/or non-improved materials that do not alter static/mechanical performance or functional tasks (active and passive).
Italy	No specific criteria have been defined yet, discussion is ongoing
Japan	I do not know any criteria.
Spain	A MN without a complex (several elements in its composition) nature A MN without a targeted structure Materials with multicomponent and targeted structured not in the nano-size.
Thailand	Materials found in nature. The by-product from manufacture.
United Kingdom	Not aware of a specific definition/criteria in this area
BIAC	Status of advanced material a transitional status which disappears as the technology matures or the material becomes commonplace for a given application.

c) What criteria would you suggest to describe the playing field of AdMa for WPMN?

Canada	It may be impossible to completely disengage from the definition question, and the lack of a definition may impede the work of the WPMN on advanced materials. The focus of the WPMN may be on preparing the ground for regulatory measures, including, but not limited to safe-by-design considerations. A way to get involved is by the categorisation of the advanced materials, starting with question 3 of this questionnaire. The WPMN could also have a role to play in the identification of the applications of the advanced materials. Canada recently took a head start at describing the landscape of applications of advanced materials in Canada, but we don't have a complete picture yet.
Germany	• A focus could be potential concern for safety and sustainability. Here, the term "Materials of Concern" is proposed to enable identification on a screening level. These initial concerns have to be supported or refuted by additional scientific data. In case the concern substantiated, the risk has to be described or at least estimated. In Germany, an Interagency Working Group was established to inter alia develop and apply early warning assessments. • UBA, BfR, BAuA have suggested, within a regulatory context, criteria to identify materials that may be of concern in terms of safety or sustainability: (i) a material meeting the criteria for classification as a "hazardous substance" or "hazardous mixture" within the meaning of the criteria set out in Annex I to Regulation (EC) 1272/2008, or (ii) a material from which hazardous substances or mixtures according to (i) can arise or be released during its production or over its life cycle, or

	(iii) a material which does not meet the criteria (i) or (ii) but which, because of its morphological, physico-chemical, chemical, (eco)toxicological or release properties, could pose a risk to human or environment during its production or over its life cycle, or (iv) a material which could pose a concern regarding additional sustainability aspects • In Giese et al (2020) a number of relevance criteria and related indicators were developed to identify those advanced materials of interest from a safety and sustainability perspective. Different dimensions of relevance are covered, with criteria from a scientific perspective (e.g. novelty of properties or manufacturing), from an economic and technical perspective (e.g. potential for market penetration or use amounts), from the perspective on hazards and risks (e.g. adverse effects and emission potential), from a regulatory perspective (e.g. legislative coverage and applicability of assessment tools) and finally from a sustainability perspective (e.g. circular economy, resource consumption). • These criteria might be considered as starting point to mark out the playing field of AdMa relevant for the objectives of WPMN.
Italy	New or improved functional properties. At least one component of the material have to be in nano-dimension, according to EU Recommendation 2011/696/EU
Japan	Inclusive criteria would be adequate for describing the playing field for the purpose of discussing the relevance of existing assessment framework for safety and sustainability of advanced materials.
Spain	Key aspects mentioned above coincide with these criteria: -manufactured -nano range -multicomponent nature -targeted structure
Switzerland	As indicated under point 1b.
Thailand	Specific on nanomaterials that combine with other materials in every field. (inorganic and organic)
United Kingdom	Advanced materials should exhibit enhanced properties that are generated by either the combination (composition) and/ or the form (e.g. size, shape) of the components within the combination and/ or the orientation of the different components in relation to each other (e.g. core-shell, or fibre matrix with attached particles).
BIAC	• The WPMN could play an important role in developing guidance for the safer and more sustainable development of advanced materials and the establishment of a "framework document" for safer and more sustainable innovation practices. • Advanced materials are essential for meeting UN sustainability goals and mechanisms to ensure their continued safe development are of importance. How could member countries promote the safer development of sustainable advanced material technologies in a timely manner?
BIAC (NIA)	Novel materials having nano-functional structures, including nano-composites with organic materials, bio materials and metals. It's better to specify those for industrial use.

3. From your point of view, which of the materials listed[4] below should be considered or not, as part of the playing field of the WPMN

	General comment
United Kingdom	In principle, we consider that all materials included below should be included initially within the scope of WPMN, however, prioritisation is important to focus effort. For some materials there also needs to be a clear reflection of the need to undertake any work in co-ordination with other OECD committee/groups (e.g. Biotechnology) and also a need to enhance the expertise of WPMN beyond the current primary focus on inorganic particulates. Perhaps this is what is intended by the category 'Partly considered'?

[4] Detailed information on the listed materials can be found at: https://oekopol.de/archiv/material/756_AdMa_Factsheets_final.pdf

Materials (Giese et al. 2020)[5]	Should be considered. Please specify	Should NOT be considered. Please specify	Should be PARTLY considered Please specify
BIOPOLYMERS (Materials based on naturally occurring polymers, which are designed for a specific functionality): - DNA-based Biopolymers - RNA-based Biopolymers - Protein-based Biopolymers - Sugar-based Biopolymers - Lipid-based Biopolymers	**[EU]** yes **[Italy]** yes **[Japan]** All **[United Kingdom]** Yes – in co-operation with Biotechnology and with enhanced WPMN expertise **[BIAC (NIA)]** DNA, RNA, and lipids are not traditionally used to prepare polymers as materials, while their natural/biological counterparts typically are created by organisms for a specific function. For example, in nature DNA is a polymer that carries information, while in technology it is often used structurally. All biopolymers	**[United Kingdom]**They could be components of an advanced material, but are not sufficient on their own. **[BIAC (NIA)]** Sugar-based biopolymers are probably closest conceptually to other types of synthetic polymers. While the sugar monomers may be of biological origin, the distinctive or unique properties arising from that biological rather than synthetic/processed origin are not very common.	**[Canada]** Biopolymers should be partly considered - It is likely that this category should be considered if the biopolymers are manufactured advanced materials. From the definition in the first column of this table: **"***Materials based on naturally occurring polymers, which are designed for a specific functionality*", we tentatively suggest edits to illustrate our thought, as such: *Materials based on naturally occurring polymers, which are designed* and engineered/manufactured *for a specific functionality or* performance advantage **[EU]** yes **[Germany]** As these materials are used in the pharmacological context more frequently, the risk assessment should be done in context with institutions like FDA and EMA. The research developments should be monitored. **[Spain]** Provided their size is within the nanomaterial definition **[Switzerland]** Might be more relevant in cosmetics or medicine.

[5]Giese B., Drapalik M., Zajcek L., Jepsen D., Reihlen A., Zimmermann T. (2020): UBA Texte 132/2020: Advanced materials: Overview of the field and screening criteria for relevance assessment. Dessau-Roßlau. Available at: https://www.umweltbundesamt.de/publikationen/advanced-materials-overview-of-the-field-screening

Materials (Giese et al. 2020)[5]	Should be considered. Please specify	Should NOT be considered. Please specify	Should be PARTLY considered Please specify
			[Thailand] The nano-size in this list should be considered. (especially Lipid base and protein base) **[BIAC]** Many of the materials within these categories are commoditized or mainstream. The status of materials should be considered on a case-by-case basis, and multiple criteria will be needed to determine if a material is advanced or not. There is currently not enough information given to decide on the status of these materials **[BIAC (NIA)]** Proteins are natural biopolymers and are often created by the organisms to perform a wide variety of functions and to have unique properties. To be considered as advanced materials, the most straightforward direction is via incorporation of non-natural functions/properties, e.g., magnetic, electronic, optical, etc.
COMPOSITES (combination of two or more materials) - Macroscopic Composites - Hybrid Materials (Materials that are a combination of organic and inorganic materials) - Fibre-reinforced Composites - Particle-reinforced Composites	**[Canada]** Composites should be considered - Canada suggests that materials not captured under countries existing regulations be considered **[EU]** yes **[Germany]** UBA: Should be considered especially with relation to release of (nano)components over the life cycle and the influence on recyclability.	**[Italy]** YES Macroscopic composites **[Spain]** If they are not particles in the nano-range. **[BIAC (NIA)]** Macroscopic composites are largely produced using traditional methods and combine properties of the constituent materials in a simple additive fashion, e.g., one layer is hard but brittle, another (protective) layer is flexible and shatter-proof.	**[EU]** yes **[Thailand]** The hybrid or particle reinforced should be consider. **[United Kingdom]** As long as the composition results in additional functionality that is not achieved by either substance on their own. However, there are many examples of such products that have existed for many decades (e.g. fibres added to polymers or to concrete), so what is different for an advanced material?

Materials (Giese et al. 2020)[5]	Should be considered. Please specify	Should NOT be considered. Please specify	Should be PARTLY considered Please specify
	BfR: Composites especially fibre reinforced composites like: a) fibres fulfilling the WHO definition may cause cancer or inflammation of the lung are used or b) potentially hazardous fibres may be released; mechanical stress/abrasion/weathering may further this process **[Italy]** YES Hybrids Fibre-reinforced Composites when fibres are in nanoscale Particle –reinforced Composites **[Japan]** All **[Switzerland]** Yes, interesting and relevant. Also on how to handle regulation on such materials. **[United Kingdom]** Yes – for materials with organic components including fibre based materials in co-operation see above **[BIAC (NIA)]** Hybrid materials (apart from those of natural origin, e.g., bone) are advanced materials, because they require specialized methods to be produced and have unique properties (not possible with the two separate components).	As opposed to a single material combining these properties. Macroscopic composites	**[BIAC]** Many of the materials within these categories are commoditized or mainstream. The status of materials should be considered on a case-by-case basis, and multiple criteria will be needed to determine if a material is advanced or not. There is currently not enough information given to decide on the status of these materials **[BIAC (NIA)]** Fibre- and particle-reinforced composites are borderline advanced materials. One criterion can be the scale or the reinforcing component and the corresponding interactions. Macroscopic fibres or particles will lead to macroscopic composites. Many microscopic composites have unique properties, even more common for nanocomposites.

Materials (Giese et al. 2020)[5]	Should be considered. Please specify	Should NOT be considered. Please specify	Should be PARTLY considered Please specify
	All Composites other than macroscopic composites		
POROUS MATERIALS (Materials which show a porous structure, differentiated by pore size) - Microporous Materials - Mesoporous Materials - Macroporous Materials	**[Canada]** Porous materials should be considered - Canada suggests that materials not captured under countries existing regulations be considered **[EU]** maybe **[Japan]** All **[United Kingdom]** Yes **[BIAC (NIA)]** Meso- and microporous materials often exhibit properties that are not merely extrapolations to low density from the corresponding bulk forms. Microporous and mesoporous materials	**[Italy]** Yes **[Thailand]** Not nano-size but if there are microporous with nanoporous structure it should be considered. **[United Kingdom]** They could be components of an advanced material, but are not sufficient on their own. **[BIAC (NIA)]** Most microporous materials do not exhibit highly unusual properties due to their porosity. Macroporous materials	**[EU]** Not all porous materials would be advanced but when pores are engineered, likely at nanoscale, for a specific properties, these are AdMa. Perhaps here further subclasses of PM could be identified, with only some designated as AdMa, probably mainly based on their engineered design but perhaps also on 'failure' of specific 'simple' macro property of PM, whatever it is, to describe it well (or for that property to be off the chart compared to conventional). **[Germany]** As some materials like zeolites are used for a long time without causing concern, materials like mesoporous silica (nanoparticles) should be considered as they may pass through cell walls. **[Spain]** If their properties are related to their pore size and their size is in the nanomaterial size definition **[Switzerland]** Might be more relevant for medicine. **[BIAC]** Many of the materials within these categories are commoditized or mainstream. The status of materials should be considered on a case-by-case basis, and multiple criteria will be needed to determine if a material is advanced or not. There is currently not enough information given to decide on the status of these materials

Materials (Giese et al. 2020)[5]	Should be considered. Please specify	Should NOT be considered. Please specify	Should be PARTLY considered Please specify
METAMATERIALS (Materials with properties that go beyond the naturally occurring properties of their components) - Electromagnetic Metamaterials - Acoustic Metamaterials	**[Canada]** Metamaterials should be considered - Canada suggests that materials not captured under countries existing regulations be considered **[EU]** yes **[Japan]** All **[United Kingdom]** Definitely as they exhibit additional functionality that is not well studied. These are key to better understand from and health and environmental safety perspective. **[United Kingdom]** Yes – but probable need to expand WPMN expertise in this area **[BIAC (NIA)]** Following the consideration in 1b, these are advanced materials by construction/definition. All metamaterials if nano structure is origin of the function No reason to exclude	**[Switzerland]** Should not be considered	**[Germany]** Should only considered, if the building blocks of these materials are nanomaterials. As very little information is available at the moment the research development should be monitored. **[Italy]** Only if the constituent parts are in nano-size **[Spain]** Provided their size is in the nanomaterial size definition **[Thailand]** The nano-size should be considered **[BIAC]** Many of the materials within these categories are commoditized or mainstream. The status of materials should be considered on a case-by-case basis, and multiple criteria will be needed to determine if a material is advanced or not. There is currently not enough information given to decide on the status of these materials
PARTICLE SYSTEMS (Properties of the materials are related to their particles' structure) - Quantum Dots - Supraparticle - Nanoflowers - Graphene	**[Canada]** Particle systems should be considered - Canada suggests that materials not captured under countries existing regulations be considered **[EU]** yes **[Germany]** Particle systems like quantum dots and graphene should be part of the playing field		**[Spain]** If they present a multicomponent nature and a targeted structure. For instance, this is not the case for graphene that could be considered as a 2D material together with a variety of other 2D materials. Similarly, some quantum dots could be considered as MN. **[United Kingdom]** As long as the composition results in additional functionality that is not achieved by either substance on their own. However, there are many

Materials (Giese et al. 2020)[5]	Should be considered. Please specify	Should NOT be considered. Please specify	Should be PARTLY considered Please specify
	of the WPMN as there is already some evidence for A)Cytotoxicity B)In some cases (bio-) persistency **[Italy]** Yes **[Japan]** All **[Switzerland]** Should be considered. To some extent they are already covered by WPMN. **[Thailand]** All in nano-size **[United Kingdom]** Yes **[BIAC (NIA)]** Following the consideration in 1b, these are advanced materials. All particles No reason to exclude		examples of such products that have existed for many decades (e.g. fibres added to polymers or to concrete), so what is different for an advanced material? **[BIAC]** Many of the materials within these categories are commoditized or mainstream. The status of materials should be considered on a case-by-case basis, and multiple criteria will be needed to determine if a material is advanced or not. There is currently not enough information given to decide on the status of these materials
ADVANCED FIBRES (fibres several µm or smaller in diameter with an intended functionality) - Organic Fibres - Carbon-based Fibres - Inorganic Fibres (e.g. silica)	**[EU]** yes **[Germany]** Advanced fibres with their high relevance for economy and their potential toxicity for humans should be certainly considered for the WPMN (Fibres with asbestos-like dimensions and short fibres (intentionally or due to abrasion)) **[Japan]** All	**[Spain]** They are not within the nanomaterial size definition	**[Canada]** Advanced fibres should be partly considered 7. Canada suggests that materials not captured under countries existing regulations be considered. - Organic fibres may be outside the scope of the WPMN/AdMa playing field **[Italy]** Yes

Materials (Giese et al. 2020)[5]	Should be considered. Please specify	Should NOT be considered. Please specify	Should be PARTLY considered Please specify
	[Switzerland] Should be considered. **[Thailand]** All combine with nano-size related should be considered **[United Kingdom]** Yes **[BIAC (NIA)]** All fibers defined as "advanced" No reason to exclude		**[United Kingdom]** As long as the composition results in additional functionality that is not achieved by either substance on their own. However, there are many examples of such products that have existed for many decades (e.g. fibres added to polymers or to concrete), so what is different for an advanced material? **[BIAC]** Many of the materials within these categories are commoditized or mainstream. The status of materials should be considered on a case-by-case basis, and multiple criteria will be needed to determine if a material is advanced or not. There is currently not enough information given to decide on the status of these materials **[BIAC (NIA)]** In many cases, these are advanced materials. But there can be more "trivial" situations, e.g., conductive fibres that are made of a conducting material, or hydrophobic fibres made of a hydrophobic material.
ADVANCED POLYMERS (Polymers with an intended functionality) - Electro-active Polymers - Magneto-active Polymers - Self-repairing Polymers - Co-polymers	**[Canada]** Advanced polymers should be considered - We have very limited knowledge of advanced polymers. We suggest keeping it within the mandate of the WPMN/AdMa until we know better where they belong **[EU]** yes **[Germany]**	**[Italy]** yes, should be considered when additional knowledge will be available **[Switzerland]** Should not be considered now, maybe at a later stage	**[Germany]** **[Germany]** BfR: AdMa like co-polymers are highly relevant in economic terms. However, the toxicity depends highly on the starting materials used (building blocks) and the selected process. So, only selected materials with shown concern should be considered. **[Spain]** Provided their size is in the nanomaterial size definition **[BIAC]** Many of the materials within these categories are commoditized or mainstream. The status of

Materials (Giese et al. 2020)[5]	Should be considered. Please specify	Should NOT be considered. Please specify	Should be PARTLY considered Please specify
	UBA: should be considered in the context of nano-enabled applications & technologies. These materials need to be reviewed regarding their safety but also other sustainability aspects. Work could be performed in cooperation with WPRM. **[Japan]** All **[Thailand]** All combine with nano-size related should be considered **[United Kingdom]** Definitely as they exhibit additional functionality that is not well studied. These are key to better understand from and health and environmental safety perspective. **[United Kingdom]** Yes – but probable need to expand WPMN expertise in this area **[BIAC (NIA)]** Electro-active, Magneto-active, and Self-repairing are all advanced functions, hence advanced materials. All advanced polymers No reason to exclude		materials should be considered on a case-by-case basis, and multiple criteria will be needed to determine if a material is advanced or not. There is currently not enough information given to decide on the status of these materials **[BIAC (NIA)]** Co-polymers may or may not lead to advanced materials, usually depending on how the different blocks affect (or not) the nano- and microstructure of the material.
ADVANCED ALLOYS - Intermetallic - High entropy - Shape memory	**[EU]** yes **[Japan]** All **[Thailand]** All combine with nano-size related should be considered	**[Canada]** Advanced alloys should not be considered - We understand that advanced alloys can be classified and regulated as either inorganic substances or nanomaterials, and	**[Germany]** For now, advanced alloys as such should not be considered within WPMN, but research development monitored. However, these materials might become relevant under consideration of Question 5.

Materials (Giese et al. 2020)[5]	Should be considered. Please specify	Should NOT be considered. Please specify	Should be PARTLY considered Please specify
	[United Kingdom] Yes, Definitely as they exhibit additional functionality that is not well studied. These are key to better understand from and health and environmental safety perspective. **[United Kingdom]** Yes **[BIAC (NIA)]** All advanced alloys No reason to exclude	they do not need further consideration from AdMa group **[Italy]** Yes **[Switzerland]** Should not be considered now, maybe at a later stage	**[Spain]** Provided their size is in the nanomaterial size definition **[BIAC]** Many of the materials within these categories are commoditized or mainstream. The status of materials should be considered on a case-by-case basis, and multiple criteria will be needed to determine if a material is advanced or not. There is currently not enough information given to decide on the status of these materials
SMART NANOMATERIALS[6] (ref to JRC)	**[EU]** yes **[Germany]** Responsive, multi-functional nanomaterials, as such or embedded in products, which are developed for application in highly sensitive sectors such as food, packaging and cosmetics should be part of the WPMN playing field. **[Italy]** Yes **[Japan]** All **[Spain]** Their structure is a nanomaterial **[Switzerland]** Should be considered, but it seems that this is a very broad field.	**[Canada]** Smart nanomaterials should not be considered - We understand that smart nanomaterials can be classified and regulated as nanomaterials, and they do not need further consideration from AdMa group	**[BIAC]** Many of the materials within these categories are commoditized or mainstream. The status of materials should be considered on a case-by-case basis, and multiple criteria will be needed to determine if a material is advanced or not. There is currently not enough information given to decide on the status of these materials

[6] https://ec.europa.eu/jrc/en/event/workshop/ec-workshop-safe-and-sustainable-smart-nanomaterials

Materials (Giese et al. 2020)[5]	Should be considered. Please specify	Should NOT be considered. Please specify	Should be PARTLY considered Please specify
	[Thailand] All smart nanomaterials should be considered **[United Kingdom]** Definitely as they exhibit additional functionality that is not well studied. These are key to better understand from and health and environmental safety perspective. **[United Kingdom]** Yes – but probable need to expand WPMN expertise in this area **[BIAC (NIA)]** Following the consideration in 1b, these are advanced materials. All smart nanomaterials No reason to exclude		

4. Are there any advanced materials that are missing under question # 3 but should be considered within WPMN?

Delegation/ Experts	Responses
Canada	No
EU	If any material exhibits "novel, innovative or improved" functions, this could be considered an advanced material, independent of the composition or structure. Functionally graded materials
Germany	- Classical materials, which release MNM during the new advanced production processes (additive manufacturing) - Nanocarrier
Japan	Although I have no suggestions for additional advanced materials to be added to the list, I recall that particles emitted from novel processes, e.g. 3D printing, was also addressed in some presentations in the WSs of advanced materials.
Thailand	I am not sure if Photonic crystals at the nano-size is in any of the group in point 3.
United Kingdom	Unsure
BIAC	The status of materials should be considered on a case-by-case basis and not explicitly by material sets.
BIAC (NIA)	Biomimetic materials (as a category of engineering advanced materials) For instance; Photonic gel rubber https://www.nims.go.jp/chikara/topics/photonic_rubber.html (for monitoring the strain of industrial structure) Morpho sheets https://www.youtube.com/watch?v=2U5ABzt_Rbk (for ID, security) Morpho textile https://www.azamiya.com/item/mmjp-1/ (no dye compounds) Gecko tapes, shark skin, lotus effect materials, spider silk, photonic materials, Cholesteric Liquid Crystal Materials (beetles-like), anti-fouling materials(snail-like), artificial muscle (as dielectric elastomer-nano composite actuator) ,,, There is no definition of Advanced materials related to Biomimetic and Biomimicry in the "ADVANCED MATERIALS –OVERVIEW OF THE FIELDFACTSHEETS ON SELECTED CLASSES OF ADVANCED MATERIALSANNEXES TO THE FINAL REPORT" As a class, materials with modified surfaces (and related surface coatings) are missing from the list. For example, a polymer fibre with a hydrophobic core and hydrophilic surface will have unique properties. Surfaces and coatings can be antibacterial, self-healing, omniphilic or -phobic, etc.

5. Do you have further considerations that are relevant in the present context?

Delegation/ Experts	Responses
Canada	Canada would like further considerations to the overlap of criteria and if it fits into several categories of advanced materials. We do not have a clear picture of how Canadian existing regulations already encompass advanced materials in Canada. We do not have a clear picture of how Canadian existing regulations already encompass advanced materials in Canada. For some categories of advanced materials listed in question 3, existing regulations may address partly or totally the category of advanced materials. It may be interesting to investigate further the question for each country/organisation/institution to tailor the WPMN work on the regulators needs.
EU	• The temporal component and functional (innovative, improved) properties are important to consider in the playing field for Advance Materials. • From a more regulatory point of view, and also from resource-efficiency and organisational point of view, it is important to set clear boundaries to the AdMa's playing field in the OECD. The WPMN should only address materials with potential regulatory relevance, i.e. that are expected to come on to the market (or already in the market), have potential for societal benefits, but there are indications that they may have a toxicological profile or may cause health or environmental effects that may not be captured well by the current chemical hazard/safety assessment methods. Even if this feature should not be used as a defining criterion or characteristic feature of AdMa, such materials should be in focus of the WPMN's work: AdMa's with 'novel' EHS profile, and for which there may exist gaps in relevant legislation or methodologies.
Germany	New manufacturing processes that uses or produces advanced (nano)materials should be considered within WPMN like additive manufacturing or electro-spinning.
Japan	Since it would be difficult to develop a necessary and sufficient list from the beginning, it would be appropriate to regard the list as a living list.
Spain	We are not sure about the group, from those mentioned above, in which some AdMa with a multi-elemental nature could be included, e.g. perovskites or imogolites.
United Kingdom	Perhaps it would help to consider the definition or the remit of the group in terms of health and environmental safety. Asking the questions 'can the safety of this material be addressed by existing methodologies?' or 'would existing methodologies adequately assess the safety of this material?' might be a useful way to focus efforts?
United Kingdom	The current strength of WPMN's expertise is primarily focussed on: 1. Inorganic materials 2. Particulates It would therefore seem appropriate for WPMNs initial advanced material focus to be on those advanced materials that in production or application could lead to particulate exposure of complex inorganic materials. This work could address, for example, whether current new/updates to TGs/GDs proposed for nanomaterials would also be applicable to such materials (i.e. a review of current projects). Any activities relating to 'complex organic' materials (and no I don't have a definition for these) or very smart/novel/active materials would require a widening of expertise of WPMN and potentially closer discussion with other OECD committees (e.g. biotechnology).
BIAC	Advanced materials are important for advancing technologies that benefit society. There is a need to get a better understanding the potential future implications of being considered an 'advanced material'—who will decide this?—and how this could impact innovation and society at large? In an ideal situation, advanced materials will continue to benefit society within a responsible development framework. Deterrents that unduly impede innovation and competition should be avoided.
BIAC (NIA)	The definition of "advanced materials" is little diffusive. So I think it's better to start the discussion on a test case, for instance on "nanomaterials-polymer composites" So we could figure out the point to focus, how to manage the nano materials in composite phase, what is the difference between nano-composite materials and articles in the conventional chemical management, and so on.