Rapid Evidence Review guidance

These Rapid Evidence Reviews are the result of findings from individual reviewers, followed by a collaborative moderation process with technology experts and the horizon scan team. This page contains the guidance given to reviewers for each field contained within the review, as well as a brief overview of the metrics A (+) denotes a quantitative score as part of the technology assessment process.

Overview

A high-level overview of how this technology is developing and the key considerations, applications, and risks.

Summary of time to market

An overview of the Technology Readiness Level (TRL) for this technology.

Potential types of Hazards

A list of hazard types which may be presented by this technology, using the PRISM list of common product safety hazards.

Summary of potential harms and benefits

A summary of the key potential harms and benefits this technology may present to the user or consumer.

Summary of non-physical risks

An outline of the potential harms and benefits this technology may present in relation to non-physical aspects such as psychological, financial, reputation, privacy, data loss, and wider cyber-security issues, such as DDOS attacks.

Technology readiness level (+)

Selected from this defined scale of technology readiness: 1 – Basic principles observed; 2 – Technology concept formulated; 3 – Experiment proof of concept; 4 – Technology validated in lab; 5 – Technology validated in relevant environment; 6 – Technology demonstrated in relevant environment; 7 – System prototype demonstrated in operation environment; 8 – System complete and qualified; 9 – Actual system proven in operational environment.

Information availability score (+)

Selected by the reviewer based on the amount of information available on the technology: 1 – No or very little information; 2 – Limited/insufficient information; 3 – Information available to partially complete review; 4 – Information available to cover and respond to all metrics; 5 – A large amount of highly relevant information.

Information quality score (+)

Selected by the reviewer based on the reviewer's confidence in the range of sources: 1 – None or irrelevant sources; 2 – Mostly google search, other journalistic outlets, or sponsored information; 3 – Other grey literature; 4 – Established technology sources; 5 – Predominantly peer-reviewed sources.

OPSS remits score (+)

A score which corresponds to the number of relevant OPSS roles and cross-cutting activities selected from a list provided to each reviewer: 1 – < 4; 2 – 4 to 7; 3 – 8 to 11; 4 12 to 21; 5 – > 21.

Scale and ubiquity score (+)

A score comprised of one-third of the market size score, one-third of the CAGR score, and one-third of the enabled technologies score. The scales are as follows:

Market size score (USD): 1 – < $1 billion; 2 – $1 to $5 billion; 3 – $5 to 50 billion; 4 – $50 to $300 billion; 5 – > $300 billion.

CAGR score: 1 – < 9%; 2 – 9-15%; 3 – 15-25%; 4 – 25-42%; 5 - >42%.

Enabled technologies score (the number of additional technologies from the longlist that are enabled by this technology): 1 – 0 technologies; 2 – 1 to 5 technologies; 3 – 6 to 15 technologies; 4 – 16 to 35 technologies; 5 - >35 technologies.

Summary of scale and ubiquity

Description of the current and projected future scale and ubiquity of this technology.

Summary of relevance to OPSS

Outline of how this technology may relate to or impact on OPSS's roles and responsibilities.

Summary of macro-scale impacts

Outline of any potential harms and benefits this technology may present at a macro-scale, across STEEP (social, technological, economic, environmental, and political) fields, for example the environmental or social impact. Additionally, this section contains any potential harms and benefits this technology may present in relation to end-to-end product lifecycle, for example during manufacture, retail or recycling and disposal.

Estimated market size (USD)

Details of any available estimate in market size, in any geography at any time, offered in the literature. In some cases, the reviewer made a judgement call to which is the most robust market size given conflicting estimates, or extrapolated to make a current global market estimate in USD.

Estimated CAGR

Details of any available estimate in compound annual growth rate (CAGR), in any geography at any time, offered in the literature. In some cases, the reviewer made a judgement call to which is the most robust given conflicting estimates, or extrapolated to estimate.

Level of harm (+)

The most relevant consumer harm severity level for this technology, based on the PRISM framework, from this range: 1 – No harm; 2 – Minor harm requiring basic treatment/first aid; 3 – A visit to A&E may be necessary with short term rehabilitation; 4 – Hospitalisation and long-lasting or permanent impacts; 5 – Potentially fatal or severe loss of function.

Time to market score (+)

A score which correlates to the TRL, based on the following scale: 1 – TRL 1-3 (research); 2 – TRL 4-6 (development); 3 – TRL 7-8 (prototyping, demonstration); 4 – TRL 9 (market ready); 5 – TRL 9+ (already widely available in market).

Harms and hazards score (+)

A score comprised half of the level of harm (described above), and half the number of potential types of hazards (described above) using the following scale: 1 – 0 (no hazard); 2 – 1 hazard; 3 – 2 to 3 hazards; 4 – 4 to 7 hazards; 5 – more than 7 hazards.

Benefits and impact score (+)

A score comprised half of the macro-scale drivers score and half of the consumer-scale benefits score, using the following scales:

Macro-scale drivers (the number of the pre-identified contextual factors that the technology may impact on, selected from a list): 1 – 0 factors; 2 – 1 to 2 factors; 3 – 3 to 5 factors; 4 – 5 to 8 factors; 5 – >8 factors

Consumer-scale benefits score: 1 – No benefit; 2 – Minor benefit (e.g. greater ease of use); 3 – Benefit (e.g. cost or efficiency savings); 4 – Significant benefit (e.g. significant improvement to quality of life); 5 – Great benefit (e.g. life0saving)

Total score (+)

The sum of the following scores, each out of 5, to give a final score out of 25: time to market, harms and hazards, benefits and impact, OPSS remits, scale and ubiquity. Higher scores indicate a higher impact technology for OPSS, while lower scores indicate a lower impact technology.

Advanced materials

Smart materials

Smart materials are materials which can respond to external stimuli, for example by adapting and changing their properties. Common examples include shape memory alloys, which can change shape in response to temperature variation, and return to the original shape when the effect is reversed, or materials such as piezoelectric materials, which can transform mechanical energy into electric charge. This review also includes metamaterials. Metamaterials are a class of smart materials that are artificially engineered to have specific, exotic properties not found in natural materials, and can be sufficiently precisely engineered at a subwavelength scale to control interactions across the electromagnetic spectrum, for example to provide electromagnetic cloaking.

Overview

Smart materials and metamaterials are defined by their responsive qualities and engineering, rather than their material properties, and as a result comprise a vast swathe of different potential material uses and applications. This review considers current and emerging significant potential smart materials and applications, though there may be many other possible applications beyond those identified in the review. Some smart materials are already in wide use – for example, optical fibers (used for fiber-optic communications), while others are at an early stage of research and development (such as metamaterials, whose development is largely driven by high-tech research in aviation and defense at present). In general, the manufacture of smart and metamaterials can be technically difficult and expensive, creating barriers to large scale use, though advances in both additive manufacturing and nanoengineering will facilitate greater development. Particularly for metamaterials, advances in AI are key to future development, as this will help to enable researchers to identify and model new metamaterials and properties from an enormous number of possible material combinations and designs. Potential applications span across energy absorption and heat transfer, sensors, imaging, computing and soft robotics, with high-profile ‘holy grails’ pursued in metamaterials research including extreme applications such as invisibility cloaks. Smart materials also have significant potential application in lighting, energy harvesting, various coatings and construction materials. The review did not identify specific physical risks posed by smart or metamaterials to end users, though it should be noted that the application of these materials in various products may create products or impacts that do pose physical risks to users.

Summary of time to market

Some specific smart materials are already market-available and have a high level of maturity (such as nickel-titanium shape memory alloys used in self-tightening bolts). Others are developed but face significant technical or cost barriers to wide-scale implementation. It should be noted that new smart materials are in continual development, and metamaterials specifically are at a significantly earlier stage of development.

Summary of scale and ubiquity

Market projections for smart materials estimate a current market of around $50 billion, with rapid growth projected in the next few years. Statista projects rapid growth in individual smart materials markets, such as smart fabrics and clothing, projected to at least double by 2025, and smart polymers, projected to more than double by 2027. Metamaterials, as an emerging area of research. Has a significantly smaller current size of less than $1 billion, but a much faster growth rate, reaching a potential CAGR of 32-34% to 2027. Again, the large number of potential applications makes it difficult to determine how ubiquitous smart and metamaterials will be, but it is likely they will have application across the fields of the built environment, transport, digital communications, consumer products and in medical fields, bringing a large proportion of the population into some contact with smart materials in daily life.

Summary of relevance to OPSS

Smart and metamaterials could potentially impact across the spectrum of OPSS responsibilities due to the wide range of potential material properties involved, from smart materials used in actual consumer products, clothing and textiles, packaging or heat and energy systems through to metamaterials used in computing and satellite and cellular communications (a key application of metamaterials is in the production of antennas for telecommunication). Smart and metamaterials also have large potential application in the field of sensing, as they can respond to a wide variety of changing properties and conditions, with potential application for example as soil sensors with agricultural and environmental application. The progression and application of these advanced materials is difficult to predict, as increased computing power and data analytic capability will allow new materials to be modelled at the atomic scale to engineer unforeseen material properties. Smart materials also have the potential to be deployed in quality and product testing and labelling, as they can respond to specific qualities and conditions.

Estimated market size (USD)	Estimated CAGR	Technology readiness level	Level of Harm (/5)
Globenewswire: $50.99 billion IMarc: $47.36 billion Verified market research: $54.1 billion	Globenewswire: 6.9% IMarc: 11.2% Verifiedmarketresearch: 14.36%	9	4

Advanced materials
Smart materials

Summary of potential harms and benefits

The review did not identify specific physical risks associated with smart and metamaterials in general, though the large number of potential materials that could be created with these specific properties could mean that some will pose independent safety risks. In addition, the application of smart materials in specific products could well pose safety risks associated with the products themselves, rather than the materials that comprise them. Some applications of smart materials have specific safety benefits, from the use of smart materials in safety equipment (e.g. smart textiles for PPE or for anti-vibration materials) to the use of these materials in packaging to detect harmful substances – as a result there is an associated potential risk due to lack of protection if the product fails or is inaccurate.

Summary of macro-scale impacts

Smart and metamaterials have enormous potential impact across multiple fields, allowing innovation and precision engineering of new products and technologies to maximise desired material qualities such as efficiency, conductivity or insulation. This could have environmental impacts (e.g. more energy-efficient buildings), social impacts (e.g. better materials-driven health and safety protections) and economic impacts (e.g. faster and more efficient communications networks). Smart and metamaterials enable the manufacture of new products and new methods of manufacture due to their unique material qualities they possess. These materials can possess beneficial qualities for manufacture – e.g. ultrastrong or ultralight materials – and can be nanoengineered with great precision. A key consideration for both smart and metamaterials is their potential end-of-life implications, as sustainability and recyclability metrics are not currently widely considered in their production.

Potential types of hazards

Lack of protection, Chemical

Summary of non-physical risks

The review did not identify any specific non-physical risks. It should be noted that, due to their specific electromagnetic cloaking potential, metamaterials could potentially have application to enhance cybersecurity.

OPSS remits score (/5) | Scale and ubiquity score (/5) | Harms and hazards score (/5) | Benefits and impact score (/5) | Time to market score (/5) | Total score (/25)

Advanced materials
Smart materials

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Summary references

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