

Discover career paths in materials science and engineering

Chris Hamlett and **Becky Waldram** share an insight into the fascinating world of materials science and engineering



What do nuclear power, sustainability, fast cars and space exploration have in common? They are just a few examples of the areas in which materials science and engineering (MSE) graduates work. The variety underlines the wide range of opportunities in both research and careers available to those who study MSE after they leave school. MSE is not taught as a subject in its own right beyond primary school, resulting in very low application rates for MSE courses at university level. This is despite 96% of graduates from MSE courses reporting being employed or in further education six months after completing their course (*Useful links: Prospects*).

What is materials science and engineering?

Materials make up the world around us and MSE is a discipline that is concerned with how the structure of a material influences its properties (Figure 1). Such knowledge can then be used to determine the best application(s) for that material. The structure of a material can refer to its atomic structure (i.e. which elements of the periodic table the material is made from), the microstructure (what a material looks like under a microscope) or the structure of the component itself. This last one can be extremely important – just consider why aeroplanes have round windows rather than square ones.

There are a wide range of different properties of a material, including mechanical properties (how an object responds to a force), chemical properties (how a material chemically reacts with its surrounding environment) and thermal properties (how well a material conducts heat). Understanding how the structure of a material influences its properties (and vice versa) allows a materials engineer to

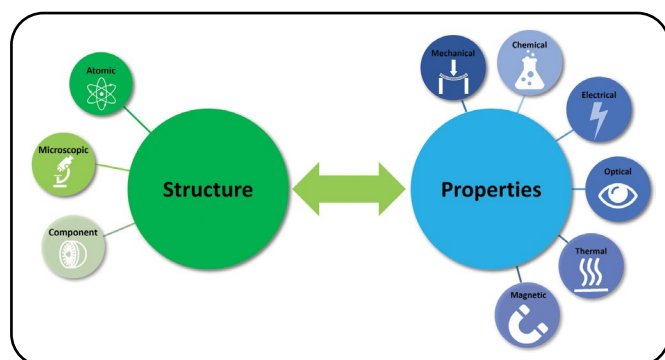


Figure 1 The structure–property relationship of materials from an MSE perspective

select the most appropriate material for a given application (or even design a new material for a specific need).

Discover Materials

Discover Materials is a working group made up of academics and outreach officers from ten UK universities and was initially set up in 2017 by the Heads of MSE departments, with a remit to increase the number of applicants to MSE undergraduate courses compared with the more traditional science and engineering disciplines (Figure 2).

In order to identify when, and through whom, to engage with students, Discover Materials commissioned a survey of 16- to 18-year-olds in 2020. The survey highlighted that a large proportion of respondents were influenced by advice from teachers and families when it came to selecting programmes of further study, and that interest in the subject content and perception of difficulty were also key factors (Coleman et al., 2021).

Where is MSE in the curriculum?

Although ‘materials science’ is specifically referenced throughout key stage 2 (ages 7–11) in the English primary school curriculum (Hamlett, Southworth and Waldram, 2023), this is not the case in older year groups.

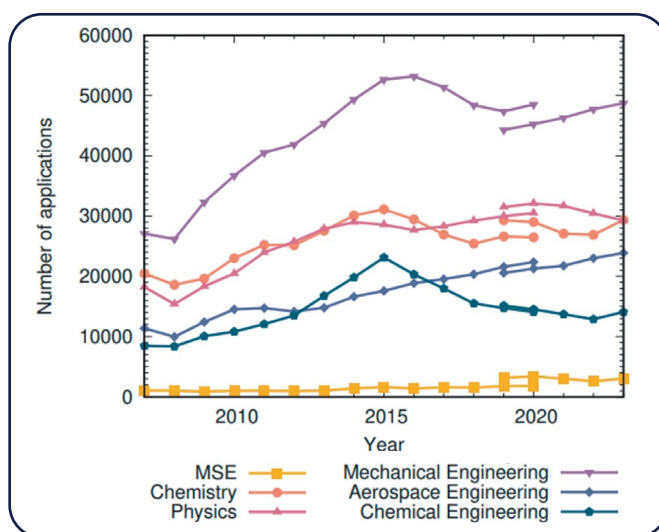


Figure 2 Graph showing the number of applications to materials science and engineering courses compared with other science and engineering degrees (data collated from freely available UCAS data by Professor Alessandro Mottura, University of Birmingham)

In **England**, the secondary school chemistry curriculum covers metals, ceramics, polymers and composites. Topics including relating bulk properties of a material to bonding are covered in key stage 4 (ages 14–16), as are reduction and oxidation reactions and smart materials. The area of electrochemical cells is covered in key stage 5 (ages 16–18) as are crystal structures, both of which form a fundamental part of first-year MSE courses.

There are also MSE topics included in the secondary school physics curriculum. The area of forces and energy transfer is covered in key stage 3 physics (ages 11–14) and expanded to include phase changes in key stage 4. In key stage 5 the curriculum covers thermal, electrical and mechanical properties of materials. Mechanical properties are specifically investigated by studying Hooke's law and measuring Young's modulus, combined with a range of imaging techniques regularly used in MSE. Aside from its relevance in chemistry and physics curricula, there are MSE topics included in design and technology (materials selection) and even in key stage 3 art and design (materials handling). It is also of great relevance to wider societal issues such as sustainability and the circular economy.

There are also many curriculum links to MSE in other UK countries across different subjects; below are a few examples (for a comprehensive list of links that we have compiled see *Useful links*):

- **Northern Ireland:** 'Using materials, parts, components, tools, equipment and processes' – CCEA GCSE Specification in Engineering and Manufacturing (ages 14–16).

- **Scotland:** 'Chemistry in society – metallic bonding, reaction of metals, metal extraction, plastics' – N5, Chemistry (ages 14–16).

- **Wales:** 'I can use my knowledge and understanding of matter to explain how different techniques can be used to extract, refine and analyse materials for a variety of uses' – progression stage 5 (ages 14–16).

Careers in MSE

There are a wide range of routes into careers in MSE, as shown in Figure 3. Given the broad reach of MSE, careers in the area are very varied, reflecting the wide range of degrees offered in this field (see *Useful links*: MSE UCAS). Aside from university degrees, there are other pathways to a career in MSE (Figure 3). For example, an academic in MSE could have reached their post by undertaking a non-materials based qualification after A-level (or equivalent) and then gone on to a career in industry before embarking on their academic post. Alternatively, a student who passed their GCSE combined science award might then undertake a technical role that could lead to a career in industry or a PhD in materials science.

In conclusion, MSE offers a wide range of career prospects, and is a fantastic career path for those who are interested in how materials can help shape our daily lives and solve global issues. It is also an accessible career path into science, technology, engineering and maths (STEM) for those who may not even consider themselves to be a scientist or engineer. MSE graduates are highly employable in a wide range of positions and industries.

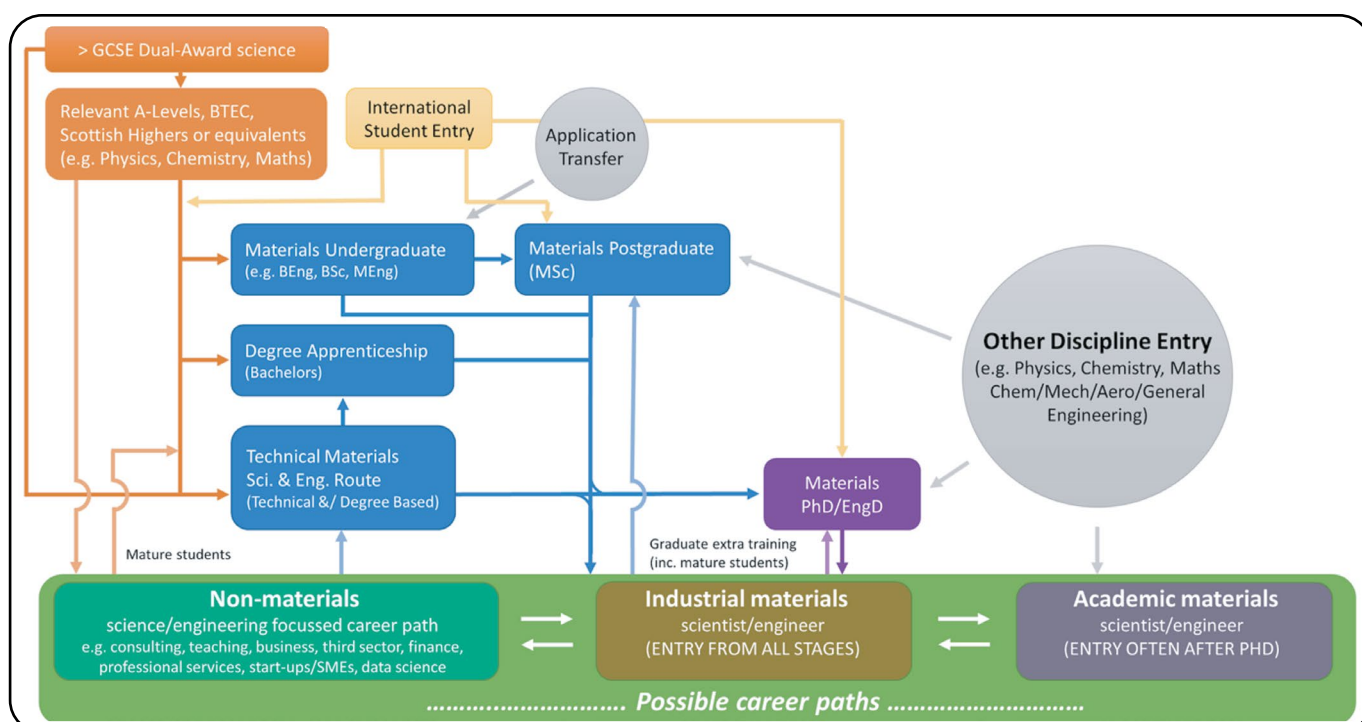


Figure 3 The various routes into MSE careers (from D'Elia et al., 2021)

How to engage with a materials scientist

- There are a range of ways to learn more about MSE careers, but the best option is to speak to a materials scientist to find out about their route into the subject (such as one of the Discover Materials Ambassadors (Figure 4) – some of their profiles can be found here: <https://discovermaterials.co.uk/discover-materials-ambassadors>

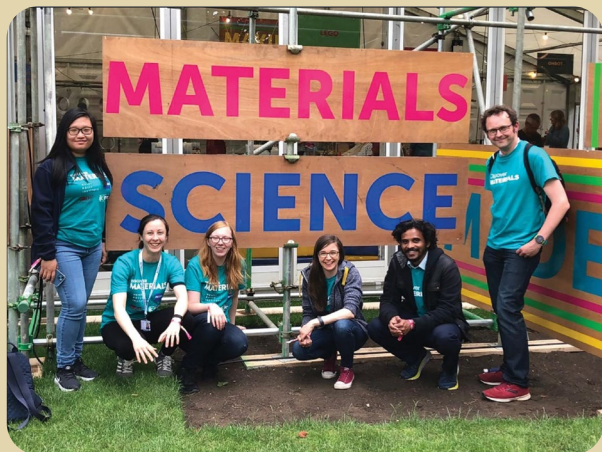


Figure 4 A group of Discover Materials Ambassadors

- Visits to MSE departments can be made during open days (see the websites of individual departments) or via the Discover Materials website: <https://discovermaterials.co.uk/contact>
- Another great source of information is the career guidance on the Institute of Materials, Minerals and Mining (IOM3) website (see *Useful links*). There are also summer schools (e.g. the Magic of Materials Summer School, a free, three-day residential summer school for 14- to 15-year-olds) and online events (e.g. the Insight Into University sessions run by Entrust).

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Useful links

Discover Materials: www.discovermaterials.co.uk

Discover Materials introduction video:

https://youtu.be/q_agKY6JJYg?si=A95_dVC8773CnvUP

IOM3 teachers' website: <https://www.iom3.org/careers-learning/schools-outreach.html>

MSE UCAS page:

www.ucas.com/explore/subjects/materials-science-and-engineering

Links to curriculum:

<https://discovermaterials.co.uk/resource/materials-science-and-engineering-in-the-secondary-school-curriculum>

Prospects. *What can I do with my degree? – materials science and engineering.*

www.prospects.ac.uk/careers-advice/what-can-i-do-with-my-degree/materials-science-and-engineering

References

Coleman, M. P. et al. (2021) *Developing a Materials World – what do students think?* www.iom3.org/resource/developing-a-materials-world-what-do-students-think.html

D'Elia E. et al. (2021) *Developing a materials world – why (not) us?*

www.iom3.org/resource/developing-a-materials-world-why-not-us.html

Hamlett, C., Southworth, A. and Waldram, B. (2023) Discover materials science and engineering in primary schools. *Primary Science*, **180**, 10–13.

Career profiles can be found at:

www.ase.org.uk/resources/school-science-review/issue-392/career-profiles-materials-science



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