HENRY ROYCE



TOWARDS MATERIALS 4.0 -WHAT IS HOLDING US BACK?

A new series of reports on:

- Digital security and trust
- Digital standards
- Lab automation
- Image storage and sharing



Developing new materials remains a slow, risky, and expensive process requiring validation at the lab-scale prior to any form of process scale-up or application related test programme. It means that a 20-year development cycle is not uncommon for safety-critical applications.

Given the considerable lifetime of many high-value technologies, infrastructures and engineered products – from aircraft and vehicles through to buildings and industrial processes – we need to bring net-zero technologies into service within the next five years, if we are to meet our 2050 net-zero commitment. Some of these new technologies require materials that we do not yet have at our disposal, so a step-change in development time is needed to maintain and further grow market share for these critical sectors of the UK economy.

Materials 4.0 is a digital materials revolution which will accelerate the discovery, innovation, and validation of new materials. It will maximise the value of materials data and link the digital and physical via cyber-physical systems for prediction, classification, and control of material performance. It will provide capability and know-how to enable the UK to respond quickly in the cross-sector adoption of a materials informatics framework, combining capabilities from risk management, materials modelling, Al/machine learning, manufacturing informatics, and life-cycle simulation.

MATERIALS 4.0 CHALLENGE

During 2020 the Henry Royce Institute supported workshops on Materials 4.0, which led to the following core recommendations:

- The need for the development of integrated tools, protocols, and methods to accelerate materials discovery, testing, and characterisation to dramatically reduce the time of materials development.
- Creation of infrastructure to meet the challenge, accelerating the pace of innovation.
- Developing demonstrators and accelerators enabling the acceleration of materials innovation across Technology Readiness Levels (TRLs).
- The need to engage, train, and develop researchers and research leaders at the interface of science, engineering, and big data to provide the skills and training needed to drive this transformation.

To explore these issues more fully, the Royce have commissioned the following reports:

Materials 4.0 - A Role for Standards: In collaboration with Ferroday we examined the standards that are currently available for digital storage of materials related data and considered the reasons that these have not been widely adopted to date.

Enabling trust in data exchange for Materials 4.0: In collaboration with Digital Catapult we considered the issues relating to data-sharing and examined methods for sharing data between competing organisations for mutual benefit.

Lab Automation for Innovation in Materials Chemistry: In collaboration with the Materials Innovation Factory at the University of Liverpool, we reviewed the use of automation and robotics to improve innovation efficiency.

Materials Microstructure Image and Data Repository Scoping Report: In collaboration with Impact Data Metrics we examined a use case for the storage of data and identified key requirements of data repositories and indexing systems.

UK CREDENTIALS AND WAY FORWARD

On the basis of these reports and the outcomes of the workshops, the Royce now proposes the establishment of a National Steering Group for Digital Materials and Manufacturing. This group will look to lead this agenda, stimulating action in:

Identification and delivery of education and training to close skill gaps - understanding the current separation of material science and information science, and contributing to the establishment of recognisable career pathways for digital materials engineers that combine both disciplines.

Landscaping - advising UK government on the current state of the transition to a digital-first materials ecosystem, including establishing relationships with regulators to accelerate the integration of emerging technologies and applications, and supporting new or revised legal and contractual requirements for these technologies.

Engagement - coordinating engagement in digital materials research within academia, industry, and the HVMC network. This would also encourage significant integration with national data strategies and with the National Digital Twin Programme at the Centre for Digital Built Britain.

The UK is well placed to capitalise on world leading research in materials and manufacturing and we are encouraging a transition towards a digital-first approach to materials R&D in order to accelerate the solving of major societal challenges. We hope this landscaping report will act as a catalyst for the materials community to have a unified voice to achieve this transition.



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