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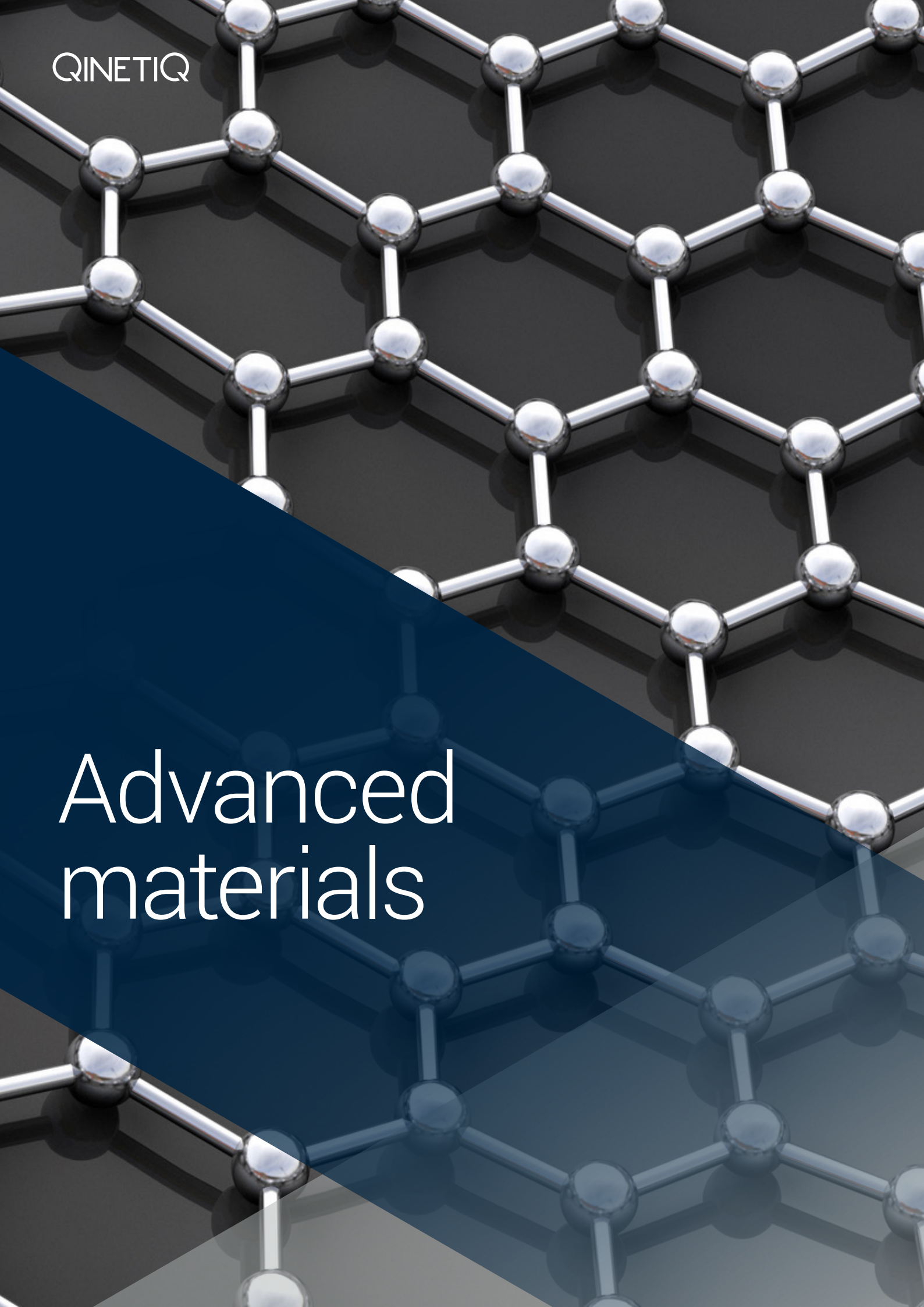

Advanced materials

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We are in what many have described as a 'Golden Age' for materials. New high performing technologies such as superstrong composites, quantum materials, and materials designed by machine learning algorithms are emerging. 'Smart' materials may have alternative functionalities, such as for example the ability to remember their shape or repair themselves, and are responsive to external stimuli.

Metamaterials exhibit properties that cannot be found in nature and have artificially engineered properties; their characteristics being defined through their structure rather than their chemical make-up.

The result is a flood of new ideas for advanced materials that could serve unfathomable purposes for the next half century and help make new things that have never been made before. Some of these discoveries may change the world. But many will fail to scale up from laboratory demonstration to commercial proposition, and fall into the so-called technological "Valley of Death" between them. Why?

More often than not, the science is not the problem. Progress in materials science is constant and new discoveries are changing the way we view the world around us every day. What holds them back is the lack of a clear process that takes over when the science stops and breakthroughs need to be shepherded through to commercial reality. This article looks at five elements of the development process for novel materials that constitute a framework for materials innovation that is designed to ensure nothing of value gets left on the shelf.

1. Take an 'Innovation Integrator' approach

Many organisations feel that they need to innovate through a rigid structured process to maintain control. But control can stifle innovation. It thrives on flexibility and the opportunity to shift gears or direction whenever an opportunity for new ideas arises. Great innovation also needs to capitalise the constant state of flux in the world around us, perpetually shifting to embrace and exploit new applications for novel materials.

A framework that encourages flex but sets out some clear parameters to help keep the innovation honest is far better – and some of the most successful innovating companies take this approach. It is much like playing jazz - there is no fixed score in any given improvisation, but that does not mean there are no underlying principles either.

Central to making this work is an expansion of the innovation process to services beyond core science and research. Incorporating a broader range of activities that support and nurture the long term success of new ideas, including product commercialisation; marketing; and training, will ensure that those designing advanced materials demonstrate the following:

(a) Responsive agility – always able to rapidly capitalise on innovative ideas and respond to challenges due to evolving threats and risks, financial and competitive pressures, and regulation and political change

(b) Focus – always accurately reflect shifting demands from the market, focussing on the most important problems and opportunities, and the innovations that drive the greatest customer benefit

(c) Unlocking the market – always able to make best use of opportunities arising from new products or technology, new ways of doing business, new ways of saving money, new systems, products and services, and new interactions and engagement

These three traits in the materials innovation approach will result in fewer novel materials left languishing on the shelf because they are less likely to fall out of kilter with what customers want. Large enterprises tend to be big supporters of this approach. But not all companies can do this on their own. Many rely on outside support and experience to help make this work, especially where their existing organisational culture could inhibit success.

2. Embrace technology transfer within the R&D phase

Contrary to popular belief, publishing research will not guarantee that someone will recognize the potential in a new discovery, and continue developing it into a tangible product that will reach the end user. That requires a technology transfer process within the research phase that can engage a wide range of researchers, promote the technology, and encourage potential industrial partners to develop it into useful products and services. Integrating the promotion of research and its outcomes into the development process ensures that once findings have been confirmed, there is already an audience for the materials produced.

This can be an incredibly complex process and a difficult one to manage, but the pace at which advanced materials are emerging from laboratories across the world and the variety now being discovered means that it is essential for strengthening the development process and preventing a 'Valley of Death' scenario. Unfortunately, many organisations working on the science and engineering behind advanced materials are small specialists, and they do not possess the experience to undertake complex technology transfer in a way that enhances, rather than diminishes, their position. That is potentially damaging and why many need expert guidance from those who adept at promoting technology research if they are to protect their interests throughout what is becoming an essential element of the advanced materials development curve.

3. Invest in productisation and IP development

Advanced materials need to be presented to the market through the lens of a user, and with clear communication of their benefits. The success of underpinning fundamental research is not sufficient to drive the application of new ideas to real world problems: people buy products not research findings. As a result, the productisation of advanced materials can be as important as their development in the laboratory. This requires several skillsets – engineering to ensure the materials are designed in a way which can be used by customers; marketing to determine the best way to sell them in a crowded marketplace; and strategy to shape the pricing and product positioning to facilitate both.

However, at the same time, intellectual property rights must be firmly established to ensure that when a novel material comes to market, the knowledge that enabled its rise is protected.

This de-risks innovation by ensuring maximum return for the effort put in, and it aids commercialisation by giving a real currency to the knowledge that underpins each material's characteristics. This contributes to higher profit margins and the ability to maintain market position. So understanding when and how to put this protection in place is an essential step towards successful innovation returns.

4. Prepare your supply chain for scale up

Supply chain and innovation might be considered very different activities but in fact they generate considerable interaction. As ideas become concepts, and eventually products or services, successful supply chains support can be designed to be flexible enough to respond to the rapidly changing needs of the environment in which new advanced materials need to be deployed. Implementing a 'designed for supply chain' philosophy – whereby the supply chain provides input early in the innovation process, for example on directional pricing and supplier capability to support – can often lead to lower lifecycle costs and greater competitive advantage. This kind of information becomes more valuable the further along the innovation process a concept moves. At a later stage, when productisation is underway, the early input allows engineers to make informed decisions on potential design features ruling out costly and risky approaches early.

Engaging the supply chain in the innovation process itself also makes it easier to scale up from concept to commercial delivery, and makes it more likely that a new material will deliver on its potential. Priming suppliers on an incoming product means they can gear up early to support as demand increases. It also encourages a more collaborative approach across the supply chain, enhancing the relationships between the various service and product providers, reducing friction, limiting the possibility of errors, and accelerating progress along the road to commercialisation.

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5. Identify exploitation opportunities through service provision

When it comes to innovation, what matters is what gets measured. And more often than not, that is how many new ideas get exploited for tangible benefit and how much impact those benefits have. Many believe that generating ideas is the easy part and exploiting them has always be the harder task. In reality neither is as important or as tricky as the filtering process that links the two. As anyone involved in the innovation process knows, more ideas fail than succeed. Failing fast is therefore a real advantage for finding the needles in the haystacks.

Exploiting innovation does not happen by chance. It requires effort and structure. As more advanced materials emerge through successful innovation processes, they need to be offered to a range of customers in different industries so they can be applied to real problems. That is not a linear process between supplier and customer. Innovating to please customers is a fool's errand because whilst there may be only a handful who want and can afford more features and better performance, firms can invest heavily in trying to deliver what this elite group wants even though the resulting products may end up beyond the reach of the majority of the market. Instead, organisations generating innovative ideas should work with a range of partners to carefully formulate exploitation opportunities together. The outside perspective will help ensure that good ideas filter through whilst the bad ones are quickly discarded.

Conclusion

Materials Science is rapidly transforming the way that everything from cars to light bulbs is made. University materials departments, spawning a vibrant entrepreneurial culture and producing a raft of new innovations. Scaling up as many as possible from laboratory demonstration to commercial proposition requires adherence to some key steps that support the transition.

Several of these steps have been outlined above as a guide. But what will make them effective is having the ability to move flexibly between each one, defined only by the required outcomes and not by the process itself. This 'mission-led' approach to innovation ensures that whilst the core components of a successful innovation process are present – the pathway is rarely linear and remains adaptable according to specific market, customer, or user needs at any point in time. For advanced materials, this is critical. Being able to create, test and put into use emerging materials with brand new properties at pace requires a level of agility that has traditionally been absent in this field. Focusing on the stages of a defined process, rather than the changing elements of a problem that needs to be solved, is too rigid if novel materials are to fulfill their potential in the real world, not just the laboratory.

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