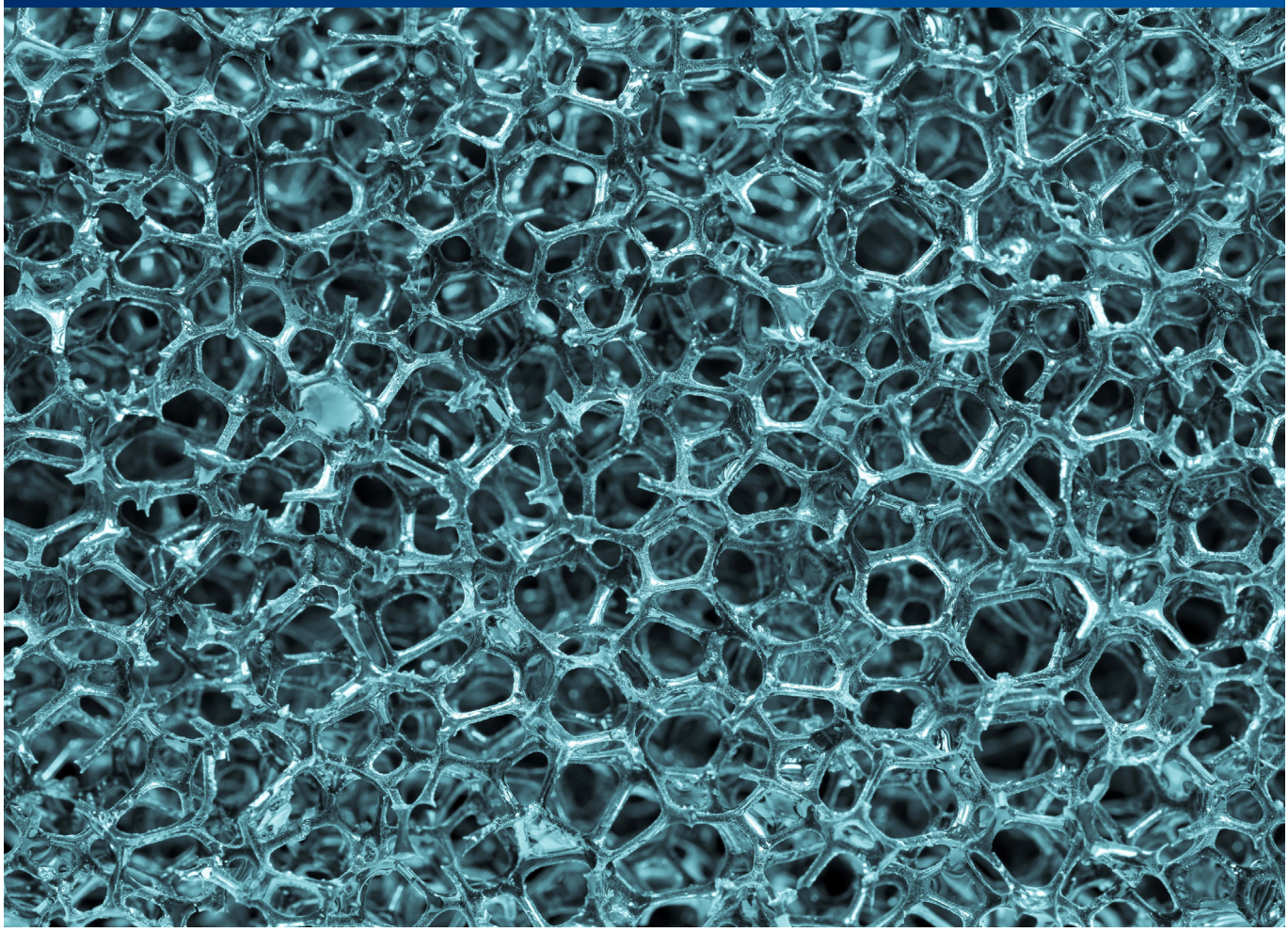
NPL
National Physical Laboratory

Supporting the scale up of sustainable fire-resistant building materials

The construction industry accounts for 37% of global emissions - Vector Homes is on a mission to make it more sustainable. Working with advanced materials researchers at the University of Manchester, they are developing sustainable materials for the built environment, including a graphene enhanced fire-retardant insulation foam. The foam performed well in the lab, but scaling production proved a challenge.

"Construction has been slow to adopt low carbon approaches," says Vicente Orts, Senior Scientist at Vector Homes. "Big building companies don't have a tradition of R&D, so they find this hard. But they do want to be greener, and we're trying to help them solve relevant problems, and work with them to get those solutions into buildings".

One such innovation was a graphene-enhanced fire-retardant foam for thermal insulation.



Challenge

However, Vector Homes was struggling to create a repeatable and reliable process for producing their foam at scale.

"We all know the importance of making building materials fire retardant, following the tragedy of Grenfell," says Orts. But most insulation foams are made fire-resistant by adding toxic halogens like chlorine or bromine, which change properties such as boiling point or stability. They are terrible for the environment and no one likes them, but they are essential to fire safety".

And whilst non-toxic additives exist, they require high doses to achieve fire resistance, which can negatively impact properties such as weight and strength.

Vector Homes has an alternative, a patented formulation that uses graphene as an additive. Graphene is non-toxic and only requires a small amount to make the foam fire retardant, whilst also improving its strength and insulation.

The formulation was shown to be exceptional in the lab, where it achieved low weight-per-meter density and a closed cell structure, an essential component of insulating materials where pores are enclosed and isolated from each other.

They were keen to explore a continuous extrusion process where polymers, graphene, and supercritical CO_2 were continually inputted into an extrusion device, combined and forced through a mould, to continuously emerge from the other end. But it wasn't working the way they hoped, with foam not hitting their required levels of quality and consistency.

Solution

Through the Measurement for Business (M4B) project, NPL examined the continuous process in detail, exploring a wide variety of production parameters and ways to measure quality of foam at various points. The idea was that this would help Vector optimise parameters such as ratio of feedstocks, gas injection, temperature across the process, etc to get a consistent product out the other side.

NPL provided a detailed list of 63 techniques for measuring foam characteristics. Examples included in-line measurements for temperature across the process, and offline measurements, such as optical measurements of foam sections for size, density and cell structure.

This led to a report summarising the various techniques and proposing a variety of production approaches, with pros and cons of each.

Impact

"Ultimately, the big thing the project quickly showed us was that continuous extrusion was not right for this application, and that a batch process was much better suited," says Orts. "That has saved us a lot of time and money by not pursuing a dead end."

"But the work also gave us lots of really valuable insights into measurement approaches, such as cell analysis techniques to understand material structure, which is helping us optimise elements of the process we are taking forward."

The data from the project also supported a successful grant application in collaboration with an industrial partner that produces fire retardants, which is now taking the process into a real industrial production system and making the leap from technology readiness level (TRL) level 4 to 7/8.

"The data from NPL was integral to the success of this grant application," says Orts. "It allowed us to justify why we were doing things in a certain way and gave confidence to the funders and our partner about our technical capability and route to commercialisation."

The hope now is that the foam will become a commercial product. That could dramatically reduce the toxic chemicals used in the fire-retardant materials required by nearly every building in the world.

"The quality of the work and calibre of the NPL scientists was very high," Orts concludes. "You can tell the NPL team were very smart and knew what they were doing. It's the best resource we could receive."

"The M4B project quickly put us onto the right track for developing the right production system for our sustainable graphene-enhanced insulation foam, whilst also giving us a lot of useful data to optimise the process, and to validate our approach to future partners and funders."

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