

Press release

Interviewserie ISIT Faces

Thomas Lisec – the mind behind PowderMEMS®

The technology he wasn't looking for

Thomas Lisec talks about the origins of PowderMEMS®, the long journey from an unconventional idea to industrial application – and why innovation requires technical infrastructure, specialist expertise and persistence.

Sometimes, a new technology begins with the solution to a problem. And sometimes, it emerges even though that very problem remains unsolved.

In 2011, Thomas Lisec was working on through-silicon vias at Fraunhofer ISIT. While looking for new approaches, he had the idea of filling deep cavities with metal powder and subsequently fixing the particles by atomic layer deposition.

The approach ultimately proved less suitable for the original challenge. But the idea became the starting point for PowderMEMS® – a process for integrating three-dimensional microstructures made from a wide range of materials into MEMS and semiconductor devices.

Today, Thomas and his colleagues at ISIT are working to further increase the technology readiness level and bring PowderMEMS one decisive step closer to industrial application.

Thomas, you came up with the idea for PowderMEMS back in 2011. When did you realise that it could develop into a technology platform?

I knew right away that the idea could be very interesting for MEMS, so I decided to pursue it. At ISIT, you have the opportunity to explore new ideas on your own initiative to a certain extent, alongside project-funded work.

By 2015, PowderMEMS had reached a level at which we were able to use the process in projects for the first time. More and more colleagues became involved in its development. In the following years, a dedicated PowderMEMS laboratory was

established, followed by the creation of the “Agglomerated Microsystems” group. By that point at the latest, I realised that PowderMEMS could become a technology platform with significant potential.

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What was the scientific question that originally led to PowderMEMS?

I still remember searching online for inspiration on how to fabricate through-silicon vias, or TSVs, in silicon substrates.

While doing so, I suddenly had the idea of filling deep cavities in the substrate with metal powder and fixing the metal particles using atomic layer deposition, or ALD.

Interestingly, PowderMEMS turned out to be less suitable for TSVs. So the original question remained unanswered.

I had discovered something I wasn’t even looking for.

What can PowderMEMS do that is difficult or even impossible with established MEMS processes?

Integrating new materials into semiconductor and MEMS technology can be very complex, because individual processes often have to be developed for each material. At the same time, MEMS require three-dimensional microstructures with comparatively large dimensions. Conventional semiconductor processes such as sputtering, CVD or spin coating can only produce such structures to a limited extent – or not at all.

With PowderMEMS, powder is filled into pre-structured cavities and then consolidated using ALD. The shape and dimensions of the microstructure are defined by the cavity, while the material the powder consists of has very little influence on the basic process itself.

This means that three-dimensional microstructures made from very different materials can be produced using the same fundamental approach. To me, that is one of the particular strengths of PowderMEMS.

PowderMEMS® at a glance

PowderMEMS® is a microfabrication process for creating three-dimensional microstructures from a wide range of materials. Powder particles are filled into pre-structured cavities and consolidated by atomic layer deposition (ALD). The geometry is defined by the cavity, while different powder materials can be used to tailor electrical, magnetic, optical, thermal or mechanical properties. The process is compatible with many substrates and established MEMS fabrication steps.

Which applications currently demonstrate the potential of PowderMEMS particularly well?

Looking at NdFeB micromagnets alone, we already have projects and collaborations – as well as potential new projects – in magnetic field sensing, energy harvesting,

quantum computing and quantum sensing, electron microscopy, medical technology and environmental monitoring.

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And NdFeB is only one material from a broad range of hard and soft magnetic materials. Magnetic effects, in turn, represent only one area of the potential applications.

What are you and your team currently focusing on?

At the moment, we are focusing less on purely scientific questions and more on increasing the Technology Readiness Level of PowderMEMS.

This involves more than optimising the core processes. For example, we need to develop suitable measurement methods for process control and characterise the powder materials we use in order to ensure consistent quality.

For powder handling, we therefore work closely with Fraunhofer IFAM. More generally, cooperation within the Fraunhofer-Gesellschaft is extremely important to us.

If we succeed in getting PowderMEMS into a first commercial product, that would be the most convincing demonstration of the potential of this technology platform.

What are the biggest technological challenges on the way towards industrial application?

Because PowderMEMS is something fundamentally new, it is not only the processes themselves that need further development. In some cases, the equipment required for those processes also has to be developed from scratch.

We have laid the foundations for this within the Fraunhofer-Gesellschaft. In the long term, however, the design and construction of production-ready equipment will have to be taken over by professional equipment manufacturers.

What determines whether a development actually makes the leap from the laboratory into industry?

The technological processes need to work with sufficient reproducibility and must be reliably monitored. The technical equipment used also has to be suitable for manufacturing.

For a potential user, the benefit must be clearly recognisable, while the risks and costs associated with technology transfer have to remain acceptable.

We need to understand the fundamental problem the user wants to solve. At the same time, long-term success depends on continuously identifying further applications and being able to adapt the technology to them.

What role does an institute such as Fraunhofer ISIT play in this process?

A very significant one. Without the outstanding resources at ISIT, PowderMEMS would not have come this far.

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Innovation requires both excellent technical infrastructure and specialists with outstanding expertise. And you need staying power: developments in the MEMS field can easily take ten years or more.

What continues to drive you after all these years of research?

I want to see PowderMEMS used in industry.

For me as an engineer, that would be immensely satisfying – a kind of knighthood.

If you were at the very beginning of your scientific career again today, would you choose the same path?

Yes. Because I was made for MEMS.

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