GERMANY

RECOSIC: Environment-Friendly, High-Grade SiC by Recycling

For more than 100 years, the raw material SiC has been synthesized for industrial applications by means of the very energy-intensive Acheson process. For the synthesis of 1 t material, around 7,15 MWh of electric energy is needed. At the same time, around 4,2 t CO_2 are emitted. 2,4 t of these CO_2 emissions are caused purely by reactions, the remaining 1,8 t CO_2 are emitted during the generation of the energy needed to produce 1 t SiC. This CO_2 balance publicized by ESK-SiC is very conservative as the energy-related emissions reflect a European power mix. In other regions of the world (e.g. China, USA, Russia), the emissions produced during energy generation are much higher.

During the pandemic, another problem for many market partners was the interrupted supply chains, which meant that SiC could no longer be reliably imported from countries like China or South America. It is therefore all the more important to create an alternative with recycled material that ensures the highest qualities in Europe. Since 2016, ESK-SiC has been working together with Fraunhofer IKTS (Fraunhofer Institute for Ceramic Technologies and Systems) on the now patented process for the production of RECOSIC. With Matthias Hausmann (MH), at ESK-SiC GmbH responsible for R&D/Technology, and Jörg Adler (JA), who heads the Non-Oxide Ceramics Department at Fraunhofer IKTS, we were able to talk about this resource-saving alternative.

CA: *What starting materials are needed for RECOSIC?*

MH: We use various by-products and waste materials that are produced during Acheson synthesis, powder preparation and subsequent processing to make SiC powders with a purity of >98 % SiC from this. After material conversion to technically high-grade SiC, the products of the recycling process then undergo the established powder preparation processes. After recycling, all material characteristics are identical or improved compared to the products available on the market. Only the CO_2 balance for the synthesis of the material is significantly improved. For the material recycling of 1 t SiC, less than 1 t CO_2 is emitted. In addition, the raw materials balance is much better as it is possible to manage almost completely without the use of primary raw materials.

CA: *From which process stages can you use material? What thermal processes are you using?*

Fig. 1
Matthias Hausmann (l.) and Jörg Adler

MH: We can start anywhere really. Material from the Acheson process satisfies only around 55 % of the requirements of our customers from technical ceramics and refractories. Lower qualities can be used in metallurgy. We can, however, feed any material with >50 % SiC content to the RECOSIC process.

In our production, during preparation of the material with regard to adjusting defined grain size ranges or morphologies, around 10 % material is produced (e.g. from air classification) that doesn't correspond the specifications. So far, attempts have been made, at great expense, to use this material to less demanding applications. It is, however, ideal for the recycling process.

JA: That applies similarly for the material produced in the customers' operations during processing (shaping, green and hard machining) as well as reject parts or components that available after the end of their use.

For the second part of your question, we can only say that in the process we have developed together we use controlled atmosphere furnaces to increase the process yield compared to the Acheson process. The RECOSIC process therefore has a yield of almost 100 %, also thanks to homogeneous process parameters in the entire reaction chamber.

CA: *What measures do you have to take in the recycling of components?*

JA: Certainly, it is essentially a matter of contamination. It is not a critical issue for components that have been used, for example, in protector vests or mechanical seals and are virtually free of contamination.

It is necessary to set up sophisticated analysis to assess these contaminated materials with regard to their behaviour during recycling, especially in the thermal process. As such components have only been disposed of so far, we have not been able to build on any empirical values. But we have already attained a good level of knowledge so that we can and must gain more in-depth know-how with industry partners. We are meeting interest here because no costs will be incurred for disposal in future and recycling is assured.

CA: *How do the materials that are fed to the recycling process influence the quality of the recycled product?*

JA: With the targeted selection of materials for the RECOSIC process, we can already customise the recyclate to meet specific parameters and modify the downstream processes, like grinding and air classification, accordingly.

CA: *How do you introduce the RECOSIC products into your customers' operations: e.g. certain applications, phased replacement?*

MH: That isn't so complicated because it really is possible to obtain the individually required parameters with the RECOSIC process at an equivalent level. Accordingly, at the customer's operations, only comparative tests are necessary.

In a second step, we can even go one better as we can produce extremely high purities >99 %. Another advantage of our process is that we can offer both "green" and "black" SiC.

CA: *When will RECOSIC be available in larger quantities?*

JA: From Q2/2022, we can supply from Dresden, where we have installed a co-financed test production facility with a capacity of several tonnes per year.

This facility should not only provide material for introduction on the market, but also verify production parameters for the construction of a plant at ESK-SiC in Frechen. Later it will be used for the scale-up of developments.

MH: In Frechen, we are already in planning for 12.000 t/a capacity and want to start with the RECOSIC deliveries in late 2023, that is the latest project status.

CA: *Where do interested customers see the crucial advantages for RECOSIC?*

MH: We have already been contacted by really big, and even listed companies, which see the approach not only as a way to achieve sustainable product qualities, but also as a way into a recycling economy and therefore to lower the specific carbon footprint of their products.

In this context, a project is underway that uses software to compare the lifecycle analyses of a classical Acheson-SiC with those of RECOSIC. This brings added value for companies that are prioritizing the reduction of their carbon footprint.

Another aspect is that, because of the pandemic, the supply from China or South America is currently very problematic on account of the enormous increases in freight costs and time delays.

In the longer term, one relevant focus is the "carbon border adjustment mechanism" as this means tax levies for CO_2 are planned at the European border in future.

Interest in SiC is growing in general, especially in the market segments technical ceramics and refractories. Applications in the chemicals or the automotive sector are increasing on account of the favourable thermal properties of SiC.

Applications in semi-conductor technology – especially for very pure SiC – or in additive manufacturing (binder jetting), with often specific requirements for particle morphology, are already showing a higher demand today.

Generally, the market values the fact that we are investing here in Germany in this new sustainable technology for Europe.

CA: *Can you already say something about the costs of RECOSIC products?*

MH: The actual production costs for the RECOSIC products will be comparable with those of the Acheson process in the long term. The analysis and pre-treatment of the RECOSIC are more complex than in the Acheson process, on the other hand the energy costs are much lower.

Currently, however, we do have to refinance the several years of development costs, the investment for the pilot facility in Dresden as well as the large facility in Frechen.

CA: *How big are the RECOSIC development teams today?*

JA: Six years ago we began the project in teams of two at each partner. Today, in my team there are five scientists, while at ESK, six full-time employees are working in R&D in this area. I can say that we are making good progress and are getting more and more positive feedback from project partners and potential customers of ESK. Of course, that boosts our teams' enthusiasm. Moreover, in the future we still see potential for the technology that we have not yet been able to address in the first step.

CA: *Is ceramitec 2022 the start for the launch of RECOSIC products?*

MH: For us, postponing of this trade fair from 2021 to 2022 was really ideal because we have a sounder basis for everything we put on show and can supply samples.
Another nice side-effect is that the company is celebrating its 100-year anniversary this year. ESK-SiC used to be part of the Wacker Group and became independent as part of a management buyout. In this context, we are delighted that we can present ourselves as a powder supplier that with innovative technology development and a sustainable recycling process for high-grade SiC can offer customers solutions with reduced carbon footprint for their production.
CA: *How do you see the distribution of RECOSIC outside Europe?*
MH: We shall be closely consulting with our partner Fraunhofer IKTS on this. We hold the relevant patents together. It is certainly possible to think about licensing the process at an appropriate point in time.
CA: *Thank you for talking to us.* KS