

Germany

ARGOLITEC: Illite-Based Mineral Products for Optimization of High-Quality Ceramics and their Production



Fig. 1 Christian Gottfried (l.) and Matthias Schuhbauer

At ceramitec 2022, Gottfried/DE premièred a new line of products on the basis of extremely fine-grained illites. The ARGOLITEC product group comprises non-swelling phyllosilicates predestined for plasticizing as well as binders and sintering aids. They are especially suitable for high-performance applications. Matthias Schuhbauer (MS), Technical Consultant for these products, and Christian Gottfried (CG), Managing Director at Adolf Gottfried Tonwerke GmbH, gave us some information on the products' development and market launch. Interesting, too, is certainly the potential use of the material to lower sintering temperatures by 50–150 K.

cfi: *What motivated you to add these materials to your product portfolio? Will your potential customer base be widened as a result?*

CG: Up to now, our own kaolinitic, refractory clays along with externally sourced materials have formed the basis for our clay and chamotte products. Now we're adding a product group of illitic clays to our portfolio, which is also widening its range of applications. These not only include ceramics, but, for example, foundries, where illite is used to partly substitute bentonite, or polymers, where the material serves as a functional additive/synergist.

cfi: *Mr Schuhbauer, you brought the material to Gottfried's attention. How did you present it as an attractive material with good availability?*

MS: Back in 2000, through an expert group working with clay mineral resources, I came into contact with a raw materials entrepreneur who wanted to expand his established but modest raw materials business with some technologically valuable additions for the future.

Through this contact, I was introduced to an extremely interesting deposit with an equally interesting raw material. Astonishingly,

no one had so far come up with a plan for the technological utilization of this deposit and the raw material. The simple but clear question "What should we do with it?" was the signal for my systematic development of products, formerly known as Arginotec now ARGOLITEC, and its marketing for different applications.

To gauge successful prospects in advance, the raw material had to be precisely assessed with regard to its availability, extractability and consistent quality, i.e. as orientation for industrial application.

With regard to working out its crucial mineralogical classification, I received excellent support from my much-respected adviser Dr Gernot Endlicher from the Institute of Applied Mineralogy at the University of Regensburg. Even at this early stage, the objective of the development in the direction of industrial application was already taken into consideration.

In concrete terms, that means that the mineralogical assessment and classification of the raw material were conducted based on combined analytics (XRF, XRD, microscopy, sedimentology, absorption analytics) by Dr Endlicher parallel to determination by me of the specific ceramic characteristics for

application in the field (shrinkage, green strength, coefficient of thermal expansion, mechanical properties and surface quality with sintering conditions adjusted in specific steps, etc.).

cfi: *Please give us a few details about the properties of ARGOLITEC.*

MS: We wanted to develop the starting material specifically for ceramic applications. We had to take certain framework conditions into account and selectively qualify the processes. One condition was that the final product should not require registration as specified in REACH Article 3, Annex V, and therefore it had to be free of any chemicals. It was important to avoid thermal processes and, during deagglomeration, not to destroy the fine illite particles down to the ultrafine range, in order to retain their high reactivity. Another requirement was the ability to dose the material very selectively. It was therefore necessary to develop suitable machine technology, building on existing and proven basis technology wherever possible. In this way, fast and reliable implementation of the product development could be enabled.

Set-up of the process engineering in stages was the solution to obtain an application-

oriented product range for wide application efficiently, i.e. without material losses, in respect of a cost-benefit comparison. At this stage of development, there was close cooperation with selected machine manufacturers and industry clients to define the ideal process technology and to take the customers' ceramics-related ideas into consideration. The variance was the ratio of illite to calcite, which could be controlled effectively with the process technology.

cfi: *What is the mineralogical structure of ARGOLITEC?*

MS: We have just under 80 % illitic and around 10 % kaolinitic phase. Swelling clay mineral phases cannot be detected, but at least 10 % very fine calcite. Mineral phases such as quartz, feldspar, haematite, etc. are not contained. The content of finest grain $<2 \mu\text{m}$ reaches almost 90 %. On this basis, product development was configured for diverse applications with a focus on ceramic surfaces (engobes and glazes) and high-grade technical ceramics, especially those with filigree and porous geometries.

An international patent was registered for the outcome of process technology and product development.

cfi: *What effect can the introduction of ARGOLITEC to ceramic formulations have?*

MS: ARGOLITEC is multifunctional and can, if dosed selectively, introduce its properties into technical ceramics bodies (oxide and silicate ceramics). The beneficial effect extends over all production steps, such as preparation, shaping, drying and thermal treatment. The powder is free-flowing and dispersible and therefore very easy to dose. For shaping, ARGOLITEC plays out its crucial properties as a high-quality plasticizer. This very fine, non-swelling three-layer silicate with ideal interaction with water has an instant and stress-free plasticizing effect. As a plasticizer, it substitutes synthetic additives for shaping, which brings big advantages, especially for extrusion.

Extrusion is the main shaping process for the application of ARGOLITEC, but it can also be used to optimize more specialized shaping processes like casting or spinning. Owing to the absence of any swelling and the resulting low drying shrinkage of only around 5 % for 100 % ARGOLITEC, drying with good green strength and stable handling builds a reliable bridge to thermal processing.

The high green strength and sintering start already under $820 \text{ }^\circ\text{C}$ enable sufficient consolidation for special applications already below common sintering temperatures.

Because of their good dispersibility, the ultrafine particles, especially of the ARGOLITEC NX nanopowder, enable finely tuned dosing and introduction in a batch formulation, so that sintering bridges are formed at different points. This happens already at low temperatures and creates optimum sintering conditions. Even for filigree and highly porous products, a reliable and stable ceramic is produced that optimally meets required application properties.

In dense ceramics, optimization of the product properties, mostly with regard to product strengths, in combination with optimization of the sintering conditions, is one application. The extraordinary sintering properties are derived from the exchange metal ions (alkali, Fe) in the phyllosilicate lattice, which is typical of illite.

Besides the process-related advantages of targeted sintering, energy efficiency thanks to lowering of the sintering temperature by around 50–150 K and the possibility of utilizing highly efficient fibre insulation in the kilns is an increasingly important aspect.

cfi: *The material was developed with ceramic manufacturers. What results have you already collected from industrial application?*

MS: The broadest approach resulted in high-porosity, filigree-structured ceramic substrate for Al_2O_3 and SiC materials. Almost without exception, ARGOLITEC NX Nanopowder is used here. An implementation in water filtration was realized back in 2003, and extended through company mergers to manufacturing in Shanghai/CN. Especially the technologically successful work in this area led to a noticeably wider use of ARGOLITEC NX for similar applications.

The above-mentioned advantages of ARGOLITEC could be quickly recognized many times over and used by a string of customers, especially for specific new developments – this despite the fact that right up to the end of 2021 the product was produced by a company that was completely unknown in ceramics/technical ceramics.

The fact that a very well-known and long-established company, Adolf Gottfried Tonwerke GmbH, has fully taken over the



Fig. 2 ARGOLITEC – the new line of products on the basis of extremely fine-grained illites

production and sales, confirms the performance of the products and will certainly break through any remaining reticence in the industry.

In addition, it should also be mentioned that, in other applications, internationally highly respected companies (e.g. in polymers for flame retardants) have trusted in ARGOLITEC for years now.

cfi: *What technical customer service in respect of body development or modification do you offer?*

MS: As the ARGOLITEC products are relatively new for the ceramic industry, it is generally necessary to initiate specific development projects. Naturally, it is expedient to concentrate the technical expertise. That is to explore development possibilities based on a comparison of customer requirements with the possibilities offered by the ARGOLITEC products.

This approach has been well accepted and therefore a good and valued partnership has grown out of it. As a result, we are automatically more or less actively involved with dedicated services in the development. As a ceramics engineer with many years of professional experience on the one hand and, on the other hand, as the person who put ARGOLITEC on this path, I can build up a constructive business relationship for both partners, customer and supplier.

CG: Service is simply a central issue in our company. It begins with the technically and commercially adapted product selection. Here, product types have already been opti-

mized, e.g. for engobes/glazes, with ARGOLITEC.

Of course, the service package is now wider at Adolf Gottfried Tonwerken. On top of this comes our exceptional expertise as a long-established company in ceramic raw materials. We understand our role clearly as that of a partner to our customers.

cfi: *Please give us a few details on availability of the material and potential further developments.*

CG: The development of the ARGOLITEC products and set-up of the business were done of course on the basis of a high and decades-long availability of the raw material. That is reliable in respect of logistics and, of course, with regard to consistent quality. That is also a crucial element in the service package. Supply of the raw material is comprehensively assured, and Gottfried, with its safeguarding of the future supply rounds off reliability for the ARGOLITEC products.

The ARGOLITEC product range in the existing form was already widely developed in respect of price-performance ratio. Special

types, for example, for polymer and foundries, have also been produced. Naturally, there exists a transparency between the applications. For example, a product type developed specifically for engobes/glazes is now used in further modified form in the polymers sector.

MS: Several years ago, a cooperative development was initiated with the Karlsruhe Institute of Technology – KIT/DE to develop a highly nanoscale product with a fineness near the primary particle size (top cut <100 nm). Production proved possible, however, product stability would still have required further development. There is certainly still potential, but the limits, however, for NX (especially polymers, coatings) are currently set by the customers' process-related facilities.

An important development goal was initially a realization of the products without the addition of chemicals, different from the nano- and organoclays on montmorillonitic basis. Naturally, that has an ecological background (not requiring registration

as specified in REACH Article 3, Annex V), but also the technological background, to selectively adapt the high surface reactivity of ARGOLITEC for product- and application-specific surface modification. That works very well with coating of the surface or selective application of metal ions. The exceptionally good dispersibility of ARGOLITEC is also used in blends/composites with difficult-to-disperse additives.

cfi: *What interest did you get at ceramitec 2022?*

CG: With the presentation of ARGOLITEC, we attracted a lot of attention and held some encouraging talks. New aspects that can open up further applications were discussed. We are delighted that, on the back of the trade fair, numerous samples have been requested, which will certainly lead to interesting outcomes and professional talks. To sum up, ARGOLITEC is an outstanding product for industrial use and moreover it has great future potential. At Gottfried, we are looking forward to very exciting times.

cfi: *Thank you for your detailed remarks. KS*