A100 Variant of Alumina: The Ideal Material for Components Exposed to Heavy Wear in Textile Machines

Major challenges are imposed on the processing of threads, fibres and yarns in textile machinery as the yarn passes through thread guides and other contact elements at high speed causing extreme wear on these parts. Contact surfaces require resistance to abrasion and high surface quality to prevent the thread from wearing or breaking. Technical ceramics and alumina materials have shown excellent results in these challenging applications. Sembach, the specialist supplier of technical ceramics, has shown how the full potential of alumina can be used by developing A100, the new super fine-grained C799 high-performance ceramic.

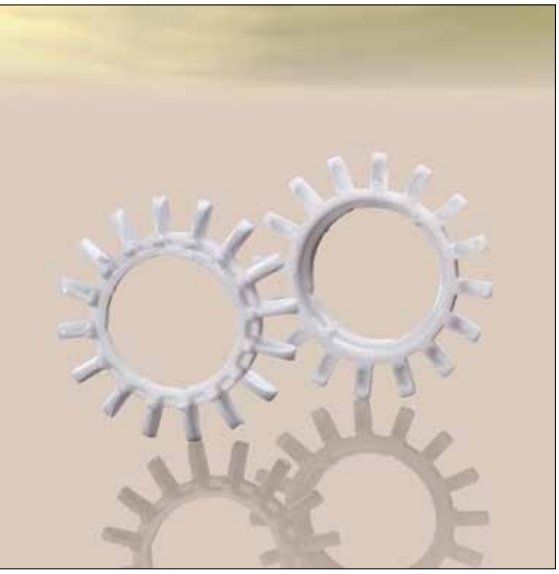

Fig. 1
Thread guide for the textile machine industry, made of A100 material

Alumina is a chemical compound of aluminium and oxygen with the formula Al_2O_3. It is one of the most important oxide-ceramic materials. For most engineering applications, alumina is produced from bauxite and, after preparation, is processed as powder in different purity grades. Depending on the grade of purity, the specific density is 3,80–3,97 g/cm³ and the melting point is 2050 °C. After diamond, alumina is one of the hardest materials. Moreover, it is characterized by high strength, wear resistance, resistance to corrosion and chemical effects as well as good dielectric properties. In addition, alumina is physiologically harmless and can withstand temperatures up to 1750 °C. Sembach has developed a process to refine the powdered source material and enhance the surface finishing of manufactured parts. A100 is a fine-grained C799 high-performance ceramic with high density. A special polishing process is used to give the manufactured parts extremely smooth and virtually non-porous surfaces.

Keywords
alumina, wear resistance, textile industry

High-performance ceramic for the textile industry

The A100 alumina variant is ideally suited to meet the textile industry's requirements for wear-resistant machine elements. The new material is based on an optimised method for the preparation of the raw material and a special polishing technique is used to finish the surface of manufactured parts. Raw material preparation produces an extremely fine-grade powder with a D_{50} value significantly below 1,0 µm and high purity that is used as source material. The Al_2O_3 content of A100 is higher than 99,97 % and has a very high density close to the theoretical density of 3,99 g/cm³ resulting in better hardness and strength properties. Components made of A100 feature perfect, non-porous surfaces that are characterized by high hardness and wear resistance due to high material density and special polishing. Another advantage of A100 is that the processed yarn is not damaged by abrasion.
A100 is therefore ideally suited for passive and active components in textile machines exposed to high stresses from wear such as thread guides and other thread guide elements, eyelets, oiling nozzles, nozzles, rollers and disks i.e. cutting disks and cutters, among others. The virtually non-porous surface allows abrasion-free processing without the risk of breaking of fibres and threads that are covered with an avivage i.e. an

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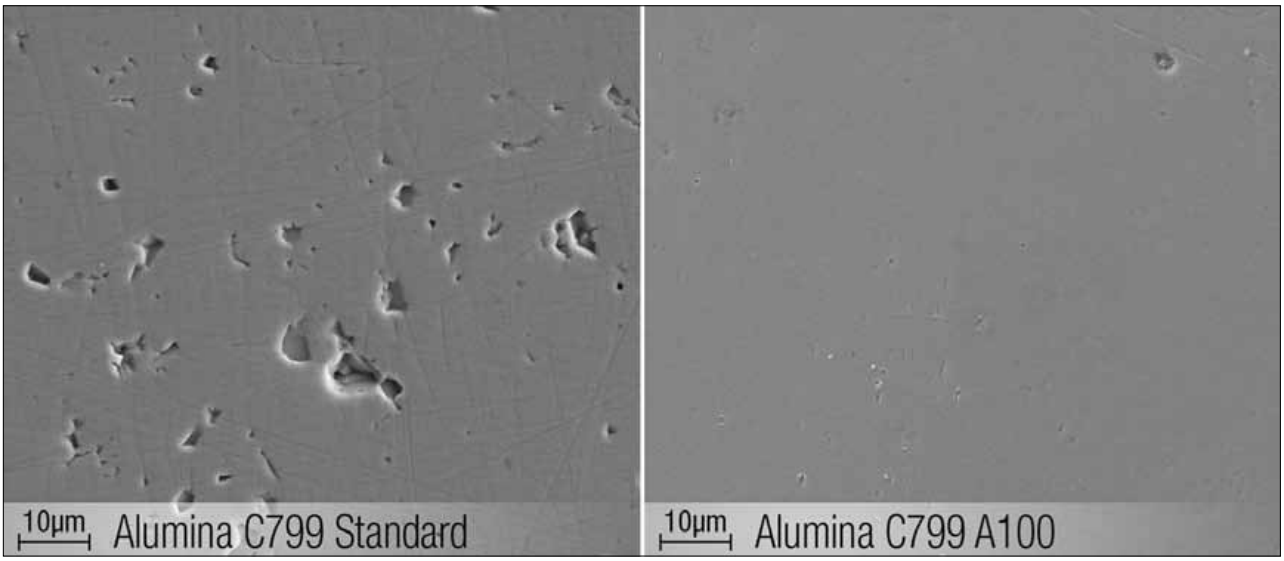

Fig. 2
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abrasive mesh. Another advantage of the extremely smooth surfaces is minimum thread tension allowing the processed yarn to be wound onto the spindle with a high winding quality. Components made of Al_2O_3, and A100 in particular, pay-off as they show no significant signs of wear in long-term use.
Basically, different ceramic materials can be used in textile machines and all of them are outstanding in strength when compared to hard metals. Zirconia, for example, is used for thread guides. The material is also highly resistant to wear and corrosion.

Resistant machine components made of high-strength ceramics

Ceramic materials in mechanical and plant engineering are exposed to constant stresses. Materials such as metal or plastic often reach their limits in challenging technical applications. Advantageous properties such as temperature resistance, dimensional stability, low wear and good electrical insulating capacity make technical ceramics ideally suited to industrial applications and contribute to increased service lives and process reliability of machines and plants.
Three properties of technical ceramics used in machine and plant engineering applications can be highlighted:

- Bending strength: bending strength is a material characteristic used for estimating the strength and dimensioning of materials. Alumina is a ceramic material with a bending strength up to 580 MPa at a temperature of 25 °C. By comparison, high-performance plastic such as polyether ether ketone (PEEK) has a maximum bending strength of 170 MPa and standard structural steel (S235JR) has 180 MPa.
- Temperature resistance: ceramic materials are suitable for extremely high operating temperatures. Alumina, for instance, withstands temperatures ranging between 1400–1700 °C. Steel, however, tolerates maximum operating temperatures up to 1000 °C and plastic up to 300 °C.
- Strength: the critical stress intensity factor (K_{1c}) defines the stress level of a material before reaching critical crack growth. The K_{1c} value of yttria-stabilized zirconia is 8 MPa $\sqrt{m}$. As a result, the material is highly resistant to so-called crack propagation and is very strong.

Raw material and process expertise

Sembach is a specialist ceramic supplier certified in accordance with the high standards of quality management ISO/TS 16949 for the automotive industry and over the course of many decades has gained extensive experience in the processing of alumina and the construction, shaping and manufacture of work-pieces made of alumina.
Modern and well-equipped production facilities allow Sembach to efficiently manufacture complex prototypes and large-batch components of A100 and other high-performance ceramics using injection moulding, dry pressing, extrusion and machining on a 5-axis milling machine.
Technical ceramics and their properties such as very high hardness, wear resistance, mechanical strength, pressure resistance or thermal shock resistance have shown excellent results as materials in machine components exposed to high stresses.
Plant and production downtime or maintenance costs can be reduced significantly with components made of technical ceramics. In addition, the Sembach injection moulding process allows the manufacture of complex components made of alumina or the A100 variant. Technical ceramics are popular materials – not only in the textile industry.