Fraunhofer IFAM

Fraunhofer Institute for
Manufacturing Technology and
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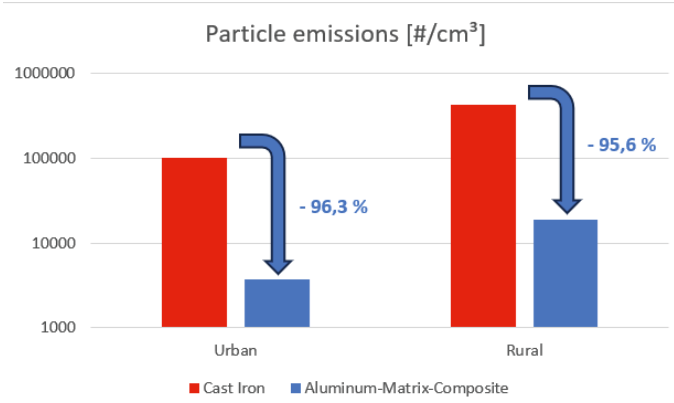
Branch Lab Dresden

Lightweight and wear-resistant

New materials for brake discs

Background

Brake discs based on Aluminium-Matrix-Composites have been originally developed for weight saving reasons. Soon a major advantage came into play: the discs are virtually wear-free, which eliminates the need for regular replacement. Over the service life of a vehicle, the initially more expensive brake discs do not cause additional costs. Being wear-free comes with massively reduced particle emissions from the brake system. As the European Union limits those particle emissions with the new Euro 7 standard, this has become a main driver for the further development of these discs.



Key Facts

- 50 % weight reduction for agile driving and increased range
- Potential CO_2 saving of 500 million tons per year in the EU
- Close to zero fine particle emissions
- No need for disc replacement during the car's service life
- Competitive costs
- Full recyclability
- Adjustable for light and heavy cars, trucks and trains

Fig. 1 Particle emissions from cast iron and composite brake discs in different scenarios. A reduction of more than 90 % allows to comply with even the strictest regulations to be applied in the European Union.

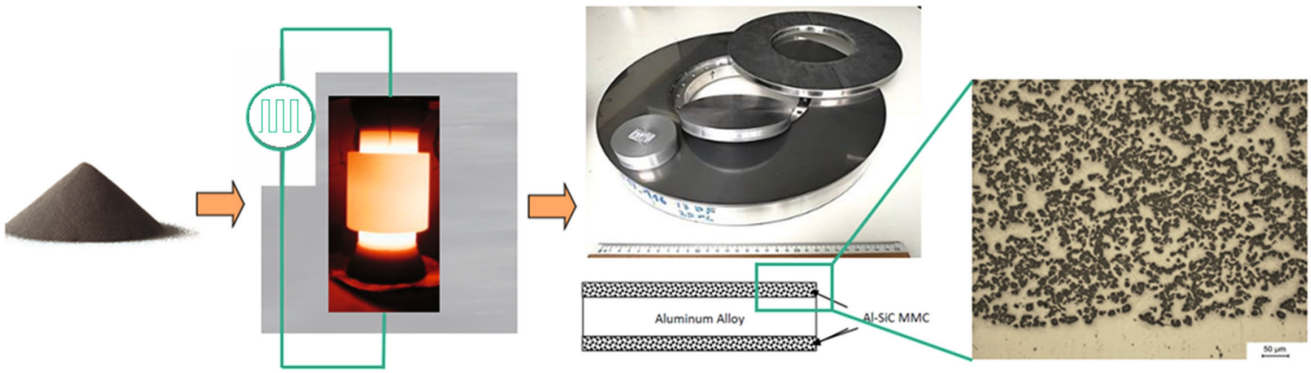


Fig. 2 Process chain for the composite brake disc production starting from the powder mixture that is sintered using spark plasma sintering with a forged aluminium disc as interlayer. The result is a sandwich disc with homogeneous microstructure and perfect interface.

Detailed Information

The innovative brake discs are produced by a combination of powder metallurgy and casting or forging. The tribologically relevant layer is made from a ceramic-reinforced light metal composite from a mixture of metal and ceramic powders by spark plasma sintering. The layer is either sintered directly on a cast or forged aluminium disc, or the disc is being cast in-between the two friction layers. This combines the high performance of the powder metallurgical composite and the low cost of conventional aluminium manufacturing.

As the whole disc is based on aluminium alloys, good recyclability is assured. As typical aluminium alloys can only be operated until approximately 400 °C, with support of the Free State of Saxony and the European Union, a material system has been developed with a maximum operating temperature of 1000 °C. This makes the brake discs suitable for heaviest cars, trucks and trains. As a special feature, no post treatment is necessary. The tribological properties are achieved directly by the process design.

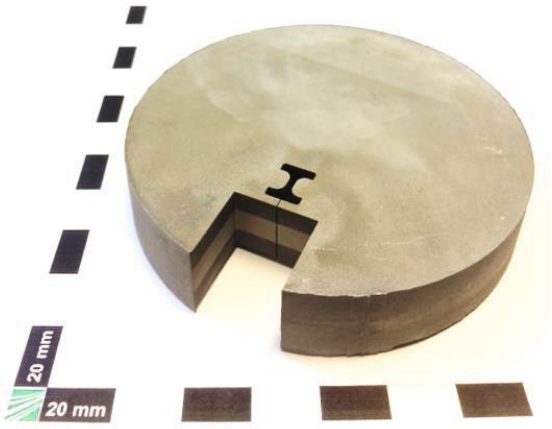


Fig. 3 A laboratory sample of a sandwich with forged aluminium interlayer and functional composite layer on both sides. The mechanical properties can be tested within the composite and across the interface.

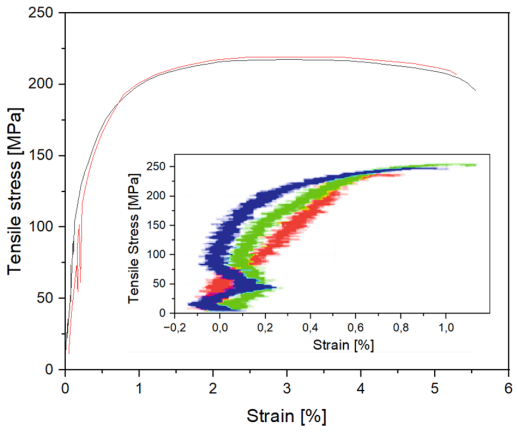


Fig. 4 The results show a high ductility. As a comparison, cast composites are very brittle and fracture after minimal deformation, as shown in the insert.

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