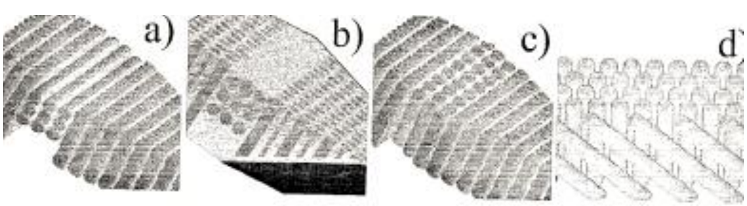
Improved Carbon Fibre Composite

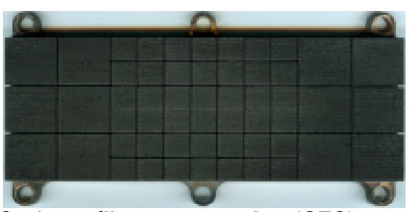
The technology presented is a novel carbon fibre composite structure with a substantially reduced erosion rate when used on surfaces subjected to heating by high velocity particle flows. The innovation relates to the arrangement of the sewing and web fibres while maintaining the actual structure of the pitch/carbon fibres that make up the main heat conducting capability. Such an improved structure reinforces the thermal shielding capability of the components and reduces the erosion rate by 4 to 5 times compared to conventional carbon fibre composite material. The technology can be used in the non–fusion domain and was patented by the inventor, Dr. Sergey Peschany.

Description of the technology

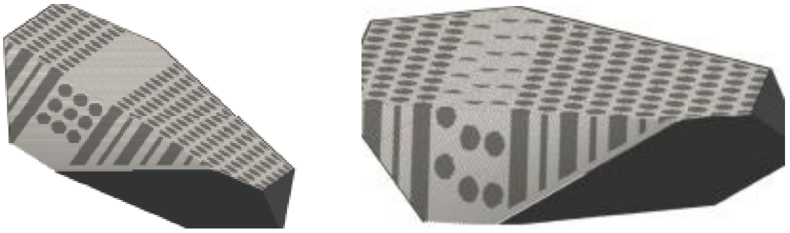
The technology is related to an improved plate--shaped Carbon Fibre Composite (CFC). Such material is used in general to protect facilities that would be damaged or even destroyed when directly exposed to heat caused by a particle flow. In order to protect such facilities, they are as a minimum shielded by CFC at the surface facing the particle flow. The technology was developed for use in the nuclear fusion domain such as for Tokamak reactors. The diverters used in such facilities are exposed to thermo--nuclear plasma enclosed by magnetic fields. If directly
without proper shielding, such diverters could not be operated in an economical manner. Therefore, they are shielded with CFC specifically developed for this purpose. The material can withstand a stationary heat flux of 10 – 20 MW/m² as well
as short bursts in the 10 GW/m² range. Conventional CFC however is subject to substantial erosion causing brittle fractures. The erosion and subsequent risk of
destruction can be greatly reduced by improvements in the arrangement of the sewing and web fibres. In particular the angle of the fibres with respect to the particle flux direction is optimized. Examples for use outside the fusion domain are
space reentry vehicles as well as airplanes operating at high speed through thin atmosphere layers. In addition, components that are operated in thick atmosphere with high velocities such as rotating blades could also benefit from the technology – in particular at the outer edge that is moving with highest velocity.



Conventional CFC (a & b) and improved (inclined) fibre structure for lower erosion (c & d) (Source: WO 2006 114161)



Carbon fibre composite (CFC) structure used in fusion for wall protection from high heat flux (Source: S. Peschany)



Conventional CFC (left) and improved (i nclined) fibre structure for lower erosio n (right) (Source: WO 2006 114161)

FUSION TECHNOLOGY DESCRIPTION

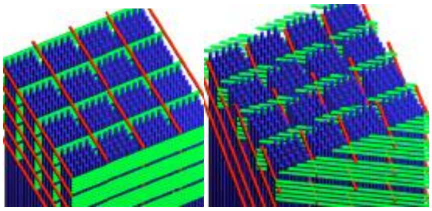
EUROfusion
TECHNOLOGY TRANSFER PROGRAMME

Improved Carbon Fibre Composite

The technology presented is a novel carbon fibre composite structure with a substantially reduced erosion rate when used on surfaces subjected to heating by high velocity particle flows. The innovation relates to the arrangement of the sewing and web fibres while maintaining the actual structure of the pitch/carbon fibres that make up the main heat conducting capability. Such an improved structure reinforces the thermal shielding capability of the components and reduces the erosion rate by 4 to 5 times compared to conventional carbon fibre composite material. The technology can be used in the non–fusion domain and was patented by the inventor, Dr. Sergey Peschany.

Innovation and advantages of the offer

The innovation of this technology for improved plate–shaped Carbon Fibre Composite (CFC) lies in the orientation of the fibres with respect to the expected particle flux direction. While maintaining the mechanical stability as well as the composition of materials involved in the composite, a substantial erosion reduction is achieved for a cost efficient use as a shielding material.



Conventional CFC (left) and improved (i nclined) fibre structure for lower erosion (right) (Source: S. Peschany)

Non-fusion Applications

Following extensive erosion simulation a well as test campaigns using plasma guns, the technology has successfully been developed but will not be used in ITER as carbon is not desirable in the facility. This technology is however promising for application in plasma machines. Further application areas are space (reentry vehicles, weight reduction of heat ablative and reusable shields), test facilities outside the fusion domain but subject to high0 energy particle flows, aviation (high speed, high altitude), rotating blades (helicopters, wind energy converters, turbine engines).

EUROfusion Heritage

The innovative CFC material was developed at the Forschungszentrum Karlsruhe that has merged with the University of Karlsruhe to become the Karlsruhe Institute of Technology (KIT). It w as successfully tested and patented. It shows superior performance, i.e. a substantially reduced erosion rate, when exposed to high0 energy particle flux. The invention is in the optimized orientation of the fibres with respect to the particle flus direction. The components contained in the CFC material as such remain unchanged. Erosion reduction allows for a cost efficient use as a shielding material in many applications outside the fusion domain including space.

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