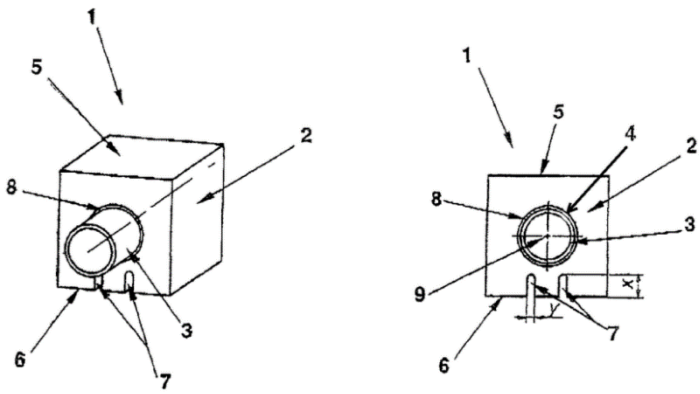
First-wall component for a nuclear fusion reactor

A leading European research institution, FZ Jülich, has developed a first-wall (i.e. plasma- facing) composite component for use in a nuclear fusion reactor. The component comprises a fibre-reinforced graphite heat shield with a lead-through that contains a CuCrZr alloy cooling tube. The component is ideal for high heat flux applications such as energy generation or aerospace, as well as high neutron or plasma backgrounds. The component has been developed and successfully tested for use in the JET nuclear fusion reactor and so is highly resistant to thermal and neutron stress, and also thermal shock.

Description of the technology

Forschungszentrum Jülich has developed a first-wall component for the nuclear fusion reactor JET, comprising a graphite-based heat shield that is material-bonded to a copper-chromium-zirconium alloy cooling tube to provide a monobloc configuration. The heat shield has (at least) one slot in the surface opposite the plasma-facing surface, as shown in the diagrammatic images below.

The heat shield is a block of fibre-reinforced graphite (40mm x 30mm x 20mm) with a concentric bore through which the cooling tube connects to the heat shield. The graphite-based heat shield is anisotropic and is optimised to withstand both thermal and mechanical stresses, as well as being highly resistant to both physical and chemical sputtering. The CuCrZr cooling tube has a thermal conductivity of >200 W/m.K, and is designed to facilitate active cooling of the component.



Diagrammatic views of a single graphitic heat shield block (according to the invention with two slots); 1 single block first-wall component; 2 graphitic heat shield; 3 CuCrZr cooling tube; 4 bore; 5 plasma-facing surface; 6 surface facing away from plasma; 7 slot (or slots, depending on selected design); 8 copper layer between the graphitic heat shield and CuCrZr cooling tube; and 9 centre of symmetry of the heat shield

The assembled first-wall component; consisting of three graphitic heat shield blocks threaded onto the CuCrZr cooling tube, and then material-bonded via a hot isostatic pressing process

EUROfusion
TECHNOLOGY TRANSFER PROGRAMME

First-wall component for a nuclear fusion reactor

A leading European research institution, FZ Jülich, has developed a first-wall (i.e. plasma- facing) composite component for use in a nuclear fusion reactor. The component comprises a fibre-reinforced graphite heat shield with a lead-through that contains a CuCrZr alloy cooling tube. The component is ideal for high heat flux applications such as energy generation or aerospace, as well as high neutron or plasma backgrounds. The component has been developed and successfully tested for use in the JET nuclear fusion reactor and so is highly resistant to thermal and neutron stress, and also thermal shock.

Innovation and advantages of the offer

This unique monobloc component is designed to withstand the extreme environment of a nuclear fusion reactor. The first-wall component is highly resistant to thermal stress and is designed to deform (rather than crack) under the thermal cycling that is typical in nuclear fusion applications. The CuCrZr alloy cooling tube is material-bonded to the heat shield via a patented hot isostatic pressing (HIP) process, allowing the favourable mechanical properties of the alloy to be retained while also curing the CuCrZr alloy automatically.

Non-fusion Applications

The first--wall component has been designed to withstand nuclear fusion reactor conditions; as such it is suitable for high heat flux and plasma applications, such as:

- oenergy generation
- aerospace
- plasma waste treatment

Visit our website to learn how fusion can help your business
www.tech-transfer.eurofusion.eu

This work has been carried out within the framework of the EUROfusion Consortium and has received funding from the Euratom research and training programme 2014-2018 and 2019-2020 under grant agreement No 633053. The views and opinions expressed herein do not necessarily reflect those of the European Commission