Actively cooled heat sink based on tungsten

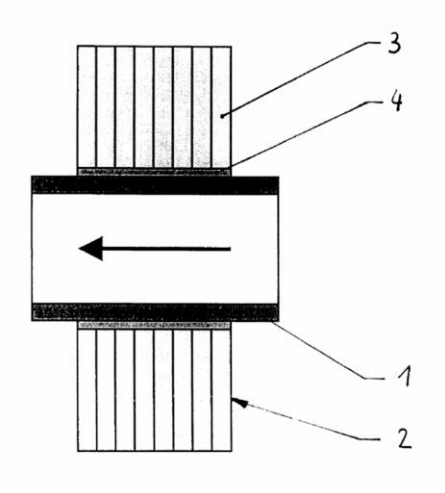
The invention consists in a composite part, such as a divertor plate for the "first wall" of a fusion reactor, adapted to endure a high thermal load, which is made, at least in some sections, of tungsten or a tungsten alloy. In accordance with the invention, the sections are not constructed massively from tungsten or a tungsten alloy, but rather are made as a laminated packet (multi-layeredness packages), with other enhanced alloys as copper, lanthanum alloy etc, in order to improve the susceptibility to fissures. This invention, heat shield is produced either as a massive block-shaped heat sink or as an actively cooled heat sink. This technology can find other suitable in other harsh environment such as Nuclear, Furnaces, Heat treatments and Materials. It can be also applied for high performances cooling systems in big science applications.

Description of the technology

The invention described above is a cooling device component in a mono-block design comprising a plasma facing material (PFM) heat shield made from tungsten, a tungsten alloy, a graphitic material or a carbidic material. This is provided with a through-hole with a pipe for a cooling fluid circulation. It meets the requirements to avoid cracking and failure of the heat shield from both physical and mechanical stresses in first-wall components in fusion reactors. The invention solves a problem that has until now prevented the implementation of shield components at large scale.This cooling device has a high melting and sublimation point and with high resistance to physical and chemical sputtering and a concurrent high thermal conductivity.

According to the invention, composites comprised of tungsten and/or tungsten alloy are provided, which are not massively constructed, but rather are made as a laminated packet. This invention permits parts made of tungsten or a tungsten alloy to withstand higher specific thermal shock stress because the parts are provided in small thickness, rather than large masses. In a particularly advantageous embodiment, the laminated packet is constructed of individual sheet metal sections each having a thickness from 0.1-2 mm. In particular, a particle-reinforced alloy comprised of 0.3-5 vol% lanthanum oxide and the remainder tungsten has proven to be suitable. With the use of this alloy, a clear reduction in the formation and propagation of fissures is attained, in comparison to earlier pure tungsten materials. In another advantageous development of the invention, the composite component adapted to endure high thermal stress is constructed as an actively cooled device wherein a cooling agent conducting tube, made of copper or a copper 526A5< 1

The component acting as the heat shield is produced either as a massive, block-shaped heat sink or as an actively cooled heat sink, with a cooling agent flowing there through made of a material having good thermal conductivity. Such later materials have a lower melting point than the heat shield and can be comprised of copper or copper alloy. Tungsten or tungsten alloys would appear to be very well suited as components for enduring high thermal stress, particularly for use as a divertor in fusion reactors, because of their high mass number, good thermal properties, and because they have among the highest melting point of all metals.



EUROfusion
TECHNOLOGY TRANSFER PROGRAMME

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Innovation and advantages of the offer

- A composite product for enduring high thermal stress comprised of at least two sections of tungsten or a tungsten alloy, wherein the sections are formed together as a laminated packet.
- The composite product, wherein the laminated packet is comprised of individual sheet metal sections comprised of tungsten or tungsten alloy each having a thickness of about 0.1-2 mm.
- The composite product, wherein the individual sections are comprised of a particle-reinforced alloy comprised of 0.3-0.5% lanthanum alloy and the remainder tungsten.
- A composite product, wherein the product is actively cooled with a cooling agent conducting tube comprised of copper or a copper alloy, which conducting tube is surrounded on all sides by said laminated packet.
- A product wherein the product is a divertor plate .
- The component acting as the heat shield is produced either as a massive, block-shaped heat sink or as an actively cooled heat sink, with a cooling agent flowing there through made of a material having good thermal conductivity.

Non-fusion Applications

This technology can find other suitable in other harsh environment such as Nuclear, Furnaces, Heat treatments and Materials. It can be also applied for high performances cooling systems in big science applications.

EUROfusion Heritage

The patent has been developed in the framework of European Atomic Energy Community (Euratom) Represented by European Commission. Euratom reach and training programme supports initiatives (framework) as FUTTA and EUROfusion with financial support for R&D. US 6565988

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