EUROfusion
TECHNOLOGY TRANSFER PROGRAMME

Technology for producing and utilising a protective layer on martensitic steel

Martensitic steel is often used when high toughness Steel with high formability is required. When such steel is used in fusion experiments, a layer to protect against losses (diffusion) of Tritium is required. The invention is a production process in which these material attributes are achieved. In a sequence of steps, the basic steel material is coated, pressurized and further hardened to achieve these characteristics. The technology is ready for use in the non--fusion domain and was patented by the inventors, Heike Glasbrenner, Kathleen Stein--Fechner and Olaf Wedemeyer.

Description of the technology

Materials used for fusion experiments have several requirements. Due to the complex structure, high formability and stability have to be combined with other properties. One of these additional properties is protection against Tritium losses through the material. Furthermore the material has to be resistant to liquid Lithium or liquid Lithium/Lead mixtures.

KIT has developed a production process where a protective layer against these losses is applied to the basic material (martensitic steel in this case). The main steps of this process are

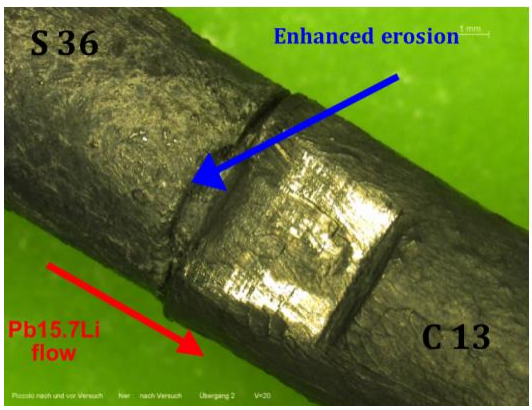
- dipping the basic material in a melt of Aluminium or Aluminium alloys
- cooling in a protective gas atmosphere
- applying high pressure to achieve the protective surface (sintering)
- hardening of the material (quenching + tempering).

The end product is a multi-layer material with a thin outer layer of aluminium oxide.
This thin layer has self-healing capabilities.

Martensitic steel component without (above) and with protective layer (below) (Source: W. Krauss, J. Konys, S--E. Wulf, O. Wedemeyer)

Innovation and advantages of the offer

The core of the invention is a new production process, which leads to a stable, self-- healing coat and the required mechanical properties for application in fusion experiments.



Behavior of martensitic steels in flowing PbLi, Martensitic steels exposed to PbLi for 10.000 h (Source: W. Krauss, J. Konys, S--E. Wulf, O. Wedemeyer)

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Non-fusion Applications

Similar technologies have been applied to the production of turbine blades. Other areas with similar material requirements might be of further interest.

- solar/thermal energy storage, H--retention, anti--corrosion barriers, (liquid metals, Pb, Sn, ...);
- nuclear, ADS such as UV Lamp production, LPD Technology.

It should be noted that protective layers are commonly used in many domains (e.g. for corrosion reduction of exhausts). However the thickness of the protection layers in those applications is still rather thick and could be further reduced by means of a process currently being developed at KIT.

EUROfusion Heritage

The technology was developed at the Forschungszentrum Karlsruhe that has merged with the University of Karlsruhe to become the Karlsruhe Institute of Technology (KIT). It was successfully tested and patented. It is currently used in a similar manner outside the fusion domain. Further developments are ongoing at KIT to improve the quality of the coating in particular with respect to a reduced thickness of the protection layer (electroplating).

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