

Low Temperature Bonding Process for High Performance Metallic Joints

Developed by TECNALIA in collaboration with Fusion for Energy (F4E), this innovative nano-sintering bonding technology enables the reliable mechanical joining of copper alloys to other copper-based or metallic materials through a low-temperature process. Utilizing a silver nanoparticle-based foil as the filler material, the process achieves sintering at reduced temperatures, forming dense, void-free metallic joints without reaching the melting point. Initially designed for applications in the electronics industry, the technology has been successfully adapted for the fabrication of components intended for high-temperature service. It has demonstrated excellent performance, scalability, and is now ready for deployment across a broader range of industrial sectors and applications requiring robust, thermally stable metallic joints.

The technology

The bonding process consists of the following steps:

- Applying a silver nano particles-based foil between the joining surfaces.
- Heating the assembly at Temperatures below 300°C under moderate pressure (~10 MPa).
- Promoting nanoparticle sintering, which creates a dense metallic bond without melting.

Despite the low processing temperature, the resulting joint demonstrates reliable performance up to 960 °C service temperature, offering sufficient mechanical strength for a wide range of non-critical applications. The foil promotes uniform interfacial contact and accommodates diverse surface geometries. This method is compatible with copper alloy systems and can be extended to other alloys through the application of simple, tailored surface coatings.

Advantages and Potential Applications

- Low-temperature joining reduces undesired thermal stresses, geometrical distortions and microstructure evolution on components during assembly and joining process.
- High thermal and electrical conductivity, with void-free and mechanically strong joints.
- Competitive, flexible and simple bonding process tested for high temperature fusion components, scalable for industrial manufacturing and compatible with filler depositing methods such as screen printing or paste dispensing.
- Material versatility, allowing its implementation with a broad range of metallic alloys.
- Adaptable to non critical mechanical joints servicing at high temperatures: power electronics, energy storage, thermal or electrical insulation and shields, exhausts, housings and supports, heat sinks and diffusers, semiconductors, repairs and overhauling, etc.

Collaboration opportunities

TECNALIA offers this advanced bonding technology to companies and research institutions across sectors that require thermally stable, high-performance metallic joints on complex material systems. The organization is prepared to transfer the technology or collaborate on projects to assess its feasibility and tailor it to new industrial applications.

Fusion for Energy Technology Transfer
Programme

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