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OO/UC3M/05 - STAINLESS STEELS REINFORCED WITH INTERMETALLICS USEFUL AGAINST CORROSION AND WEAR

A Spanish University Research Group has developed an innovative family of composite materials is presented. Metallic matrix are austenitic and ferritic stainless steels, and as reinforcements, intermetallics ($AlCr_2$, γ - TiAl, Ni_3Al, NiAl, Fe_3Al, etc.) have been used in quantities from 1% to 15% (vol.). These materials combine excellent properties against corrosion and wear, so they become very useful for structural applications, in areas like aerospace and automotive.
The research group is trying to find companies in order to establish license agreements and/or collaborative projects for the technology development and validation. The companies profile sectors would be the manufacturers of materials, components or structures for aerospace and automotive areas.

Description of the technology

Powder metallurgy consolidation of the materials developed was done. In this process, materials in form of powders are blended, compacted (uniaxially and through cold isostatic pressing) and finally sintered (in inert atmospheres, vacuum, dissociated ammonia and nitrogen based atmospheres) at different temperatures between 1100 and 1250 ºC. Sintered stainless steels present three main problems: their corrosion resistance is poor (compared to wrought stainless steels), they are relatively soft (so their wear resistance is not good) and they are sintered in high temperature non-industrial atmospheres. Trials made to improve their corrosion resistance diminish their wear behaviour, and opposite. On the other hand, intermetallics appear as a solution for high temperature structural applications, being hard and corrosion and oxidation resistant. Despite this, they have not been widely used as reinforcements in metal matrix composites.

The responsible research group has a wide expertise in the following areas:

- Synthesizing new metallic materials and/or composite materials with a metallic matrix.
- Studying and analyzing materials: establishing thermal, mechanical, structural and microstructural properties and corrosion and wear characteristics, with the aim of observing the performances and failures of materials in service and developing new alloys and compositions of industrial interest.
- Studying and developing recycling processes for materials with high added value and/or environmental impact, as is the case of titanium, aluminium and slate dust and shavings.
- Applying powder technology to the forming of materials by means of mixing, compacting, sintering or injection moulding processes.

Innovative aspects

The addition of these intermetallics to powder metallurgical stainless steels is a highly innovative technology, which main benefits are two. On one hand, they allow to sinter in nitrogen base industrial atmospheres, so processing of these materials is cheaper. On the other, the obtained materials present excellent wear and corrosion behaviour, due to the adsorption of nitrogen from the atmosphere by intermetallics.

Moreover, these composite materials present a microstructure perfectly coherent between matrix and reinforcement, being formed an interphase due to reaction between them.

Competitive advantages

From the point of view of their performance, these innovative composite materials present lightness and excellent corrosion and wear resistance, better than stainless steels reinforced with particles other than intermetallics, like oxides or carbides.

From the technological point of view, these materials can be sintered in industrial atmospheres typical from other ferrous alloys, so processing of components has lower costs due to using the same

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Competitive advantages
furnaces and specially because processes are continuous (in front of non-continuous actually used of vacuum or hydrogen).

Current state of intellectual property: ☒ Patent granted

Keywords
Mixing (powder, etc.), separation (sorting, filtering); Iron and Steel, Steelworks; Metals and Alloys; Properties of materials, Corrosion/Degradation.

Contact Person: María Dolores García-Plaza
Phone: + 34 91 624 9016 / 9030
E-mail: comercializacion@pcf.uc3m.es