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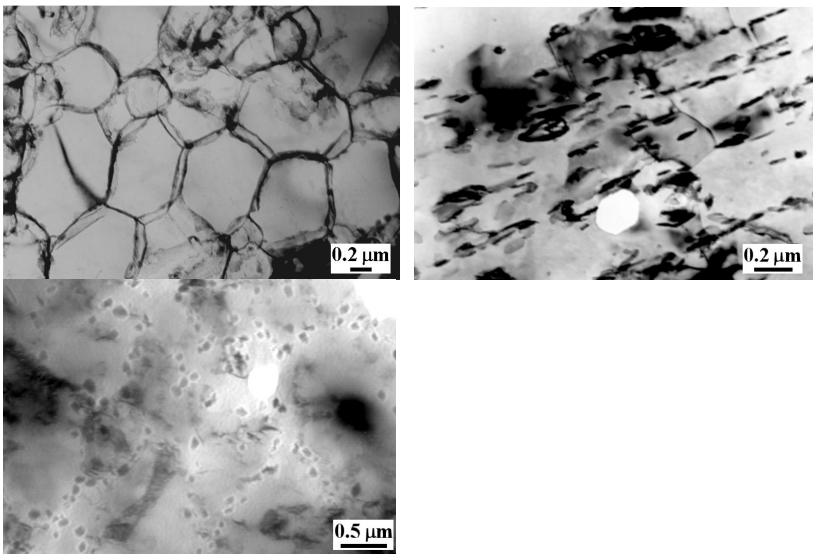
HIGHTEMAL: Bulk nanostructured Al profiles for applications at elevated temperatures

PROJECT DESCRIPTION

The project is directed to the development and the manufacturing of lightweight aluminium alloys with enhanced thermal stability up to 400 °C along with other exceptional features. In generally, developing alloys are based on rapidly quenched starting material in the form of discrete particles (powders, chopped ribbons). Consecutively, the starting material is consolidated by means of suitable powder metallurgical techniques into bulk compacts aimed for structural applications. All used PM routes are objected to be feasible also at industrial scale. Three different approaches have been investigated in order to prepare targeted materials:

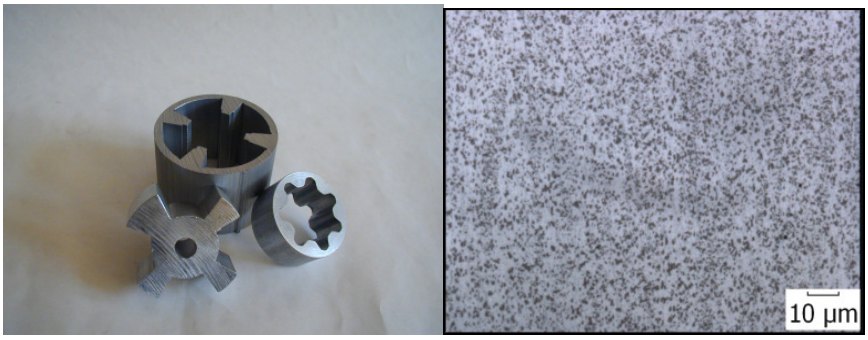
- compacts of ultra fine-grained gas atomized pure Al powders, which properties stem from the extraordinary stabilization and strengthening effects of in-situ introduced nano-metric Al2O3 dispersoids. In-situ Al2O3 dispersoids originate and form from ~3nm thick native oxide skin present on as-atomized Al powder particles. Material offers superior mechanical properties, creep behaviour and structural stability at elevated temperatures even after prolonged high temperature exposures Depending on the processing route, native oxide skin layer either disrupts into separate nano-metric dispersoids or remains as continuous interpenetrating layer within final compacts. Amount, morphology and distribution of nano-metric oxide dispersoids significantly affect the properties of compacts.



TEM images of ultrafine Al powder compacts prepared via forging (left) extrusion (middle) and HIP (right)

- compacts of rapidly solidified melt-spun AlCr5Fe0,85 (at.%) ribbons or gas atomized powders. The excellent thermal stability of compacts was a consequence of very slow diffusivities and low equilibrium solubility of Cr and Fe in solid Al. High strength (e.g. 305 MPa at long term exposure at testing temperature of 300°C) along with reasonable ductility of compacts was given by supersaturated α-Al, fine nature of α-Al grains and strengthening effect of nano-metric homogenously distributed quasicrystalline phases. The material properties during the service at elevated temperatures are superior to any conventional Al alloy. Furthermore, good formability of AlCr5Fe0,85 at elevated temperatures along with required structural stability enables consolidation of starting material at low extrusion pressures. That makes potential up-scaling of presented procedure feasible.

- composites prepared by consolidation of Al based alloy powder and ceramic particulates mixtures. Relatively simple, large scale technology, where expensive steps of encapsulation or HIP are avoided, was established. Alongside with excellent thermal stability and good mechanical properties of compacts increased Young modulus over 100 GPa and wear resistance are obtained.



The various engine parts made from industrially extruded profiles from developed materials and their fine composite microstructure

PARTNERS:

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PROJECT DURATION AND TOTAL PROJECT COST:

Duration: 01/01/2008-31/12/2010
Cost: 1 142 k€ / funding 405 k€

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