Metal-Metal Matrix Composites

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The worldwide requirements for reducing the energy consumption and pollution have increased the demand of new high performance lightweight materials to be used in vehicles.
Thus, developing materials with very high specific strength at elevated temperatures but having sufficient ductility to be forged, and also having enough toughness and fatigue resistance to avoid catastrophic failures is a big challenge in the Aluminium metallurgy.
Aluminium based matrix composites (AMCs) became an important class of engineering materials because of the higher performance that they offer over traditional alloys. AMCs have been the most developed and utilised for a wide range of engineering applications, particularly in aerospace, defence and automotive industry among others. Traditional AMCs are reinforced by ceramic or non-metallic particles or fibers which increase the strength and stiffness of the Al alloy matrix at the expense of ductility, toughness and fatigue resistance. In order to meet the required combination of properties necessary in high performance dynamic components of internal combustion engines, the use of metallic reinforcements and particular plastic deformation processes are investigated.
Some strategies consist in using severe plastic deformation techniques in order to obtain submicron fibres. Others, consist in the use of a very high strength nanoquasicrystalline alloy with pure metal particles as ductilizers, or using commercial Al alloys as matrix and a high volume fraction of strong metallic quasicrystals. Finally, complex composites combining all these metallic materials are discussed.
Examples of several metal-metal composites are presented. Powder metallurgy, hot extrusion and cold rolling techniques have been used to manufacture the composites. The microstructure was characterised by means of X-ray diffraction, electron microscopy, EDX and EBSD. In-situ tomography studies with synchrotron radiation under compression were performed to observe the strain field distribution during the deformation process and the effect of the particles reinforcements in the fracture initiation.