ABSTRACT

Severe plastic deformation (SPD) is one of the methods of obtaining very fine crystalline structure in different bulk metals and alloys. SPD causes the formation of micrometer and sub-micrometer sized subgrains in the initially coarse grained materials, as a result of which enhanced mechanical performance is obtained. Equal-channel angular pressing (ECAP) is an SPD process that is used to impose large plastic strains. The present thesis aims to address the role of processing routes of ECAP on microstructure, mechanical properties and TEM investigation for Commercially pure Aluminium, Commercially pure Copper and Commercially pure Titanium.

Commercially pure Aluminium (FCC), after initial characterisation for chemical composition, microstructure and mechanical properties, was deformed in ECAP using 90º channel angle die. The aluminium cylindrical rods with 12 mm dia and 60 mm length were processed up to 7 passes using route B_C at room temperature and then characterised for optical microstructure, mechanical properties, X-ray diffraction analysis and TEM analysis. Results show that ultra fine grains are produced in ECAP. The grain refinement and mechanical properties improve with increasing passes in ECAP.

Similarly commercially pure copper (FCC) was successfully processed using a die having channel intersection angle ψ=90º and angle of curvature ϕ=20º in route B_C. ECAP was carried out upto 10 passes at room temperature. The imposed strain resulted in a large reduction in the grain size to submicron level. Microstructure and mechanical properties of commercially pure copper rods processed by equal channel angular pressing were investigated. The grain size and micro strain were calculated from XRD data using Williamson Hall Method. Micro hardness and micro tensile values of ECA pressed copper increase with increase in the number of passes.

After processing the commercially pure aluminium and commercially pure copper with ECAP, this process was applied to commercially pure Titanium. CP-Ti being an HCP material cannot be processed at room temperature, so it was done by hot pressing in a die having channel intersection angle, ϕ of 90º and angle of curvature, ψ of 35º in route B_c at 723 K. The grain size and micro strain of ECA pressed Cp-Ti was studied by X-ray diffraction method. The microstructure of ECA pressed Cp-Ti was investigated by optical microscopy and Transmission Electron Microscopy (TEM). Also, the mechanical properties such as micro hardness, tensile strength and ductility of the ECA pressed Cp-Ti were measured. The experimental results confirm grain size reduction with no secondary phase formation. The changes in the mechanical properties of ECA pressed Cp-Ti increase with increasing number of passes due to the formation of twins in the grains and grain boundaries of ECA pressed Cp-Ti.