

Grain refinement by mechanical techniques

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There is an increasing interest to develop polycrystalline materials with very fine grains in submikron range or even in nanometer size. Severe plastic deformation is a possible technique to produce such materials. The following processes have been proposed to produce bulk materials: Hydrostatic Pressure Torsion (HTP), Equal Channel Angular Extrusion (ECAE), wire drawing, alternative extrusion, Continuous Confined Strip Shearing (C2S2), Accumulative Roll Bonding (ARB), Repetitive Corrugation and Straightening (RCS). Nanostructured materials are also developed by Ball Milling process; they are, however, in powder form.

The above techniques are briefly discussed in the presentation. They are also evaluated in terms of effectiveness of the refinement and strength characteristics (deviations from the Hall-Petch law). The microstructural plastic deformation processes are also discussed, especially the role of dislocations, stacking faults and diffusion processes in nanomaterials.

The microstructural processes that lead to grain refinement are discussed. It is suggested that large plastic strain gradients enhance the grain subdivision process. As an example, the most widely used ECAE technique is analysed in terms of strain path and strain gradient characteristics.