PURE COPPER DEFORMED BY EQUAL-CHANNEL ANGULAR PRESSING (ECAP)

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ABSTRACT- Severe Plastic Deformation processes (SPD) have acquired a grate importance in the last decades in the production of nanostructured materials. Different processes have been developed by several research groups around the world and interesting results have been reported in the bibliography [1-5]. However, one of most attractive SPD processes is the Equal-Channel Angular Pressing (ECAP, see fig.1) because bulk materials with excellent mechanical properties and homogeneous deformation are produced by this technique. The aim of the present work is to study several aspects related to the microstructure obtained due to the ECAP process following a particular and most effective route (Route Bc) on pure copper samples and their influence on mechanical properties. Starting 99,98% pure Cu samples with an average grain size of ~60 μm (fig. 2) were processed at room temperature by Equal-Channel Angular Pressing (ECAP) introducing severe plastic deformation. The microstructure and properties survey was carried out by microscopy and mechanical characterization. A significant decrease in grain size was observed by transmission electron microscopy resulting after 8 passes through the die, in grain sizes in the order of 250nm (fig. 3). Tensile and microhardness tests were carried out on the deformed material in order to correlate microstructure and mechanical properties. From the first passage through the ECAP die, an increase in mechanical properties was reported with a gradual small increase for the subsequent ECAP passes (table 1). The mechanism for the process has been studied and several steps can be related starting from deformation, dislocation motion, cells/subgrain generation (LAGB), and stabilisation as (HAGB).

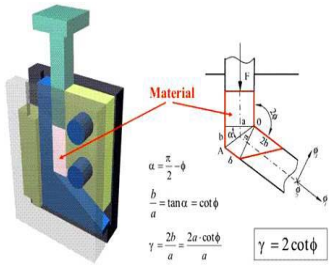

Fig. 1 Test system of the equal-channel angular pressing.

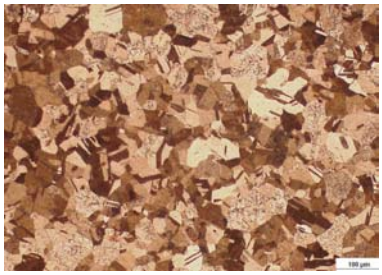

Fig. 2 Microstructure of pure copper after annealing at 600ºC for 2 hours.

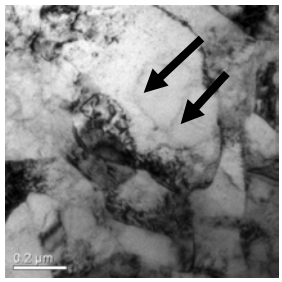

Fig. 3 TEM image of a processed sample (ECAP) after 8 passes.

Table 1: Material Characterisation and properties

Sample	Grain Size (µm)	Hardness HV	Dislocation density ρ (m^{-2})	YS(MPa)	UTS(MPa)	%RA*
Annealed	65	70 ± 2	1.00E+14	200	275	95
1 pass	15	139 ± 5	3.45E+14	337	411	90
2 passes	0.99	150 ± 5	4.02E+14	415	429	91
3 passes	0.37	151 ± 3	4.89E+14	424	458	87
4 passes	0.34	152 ± 4	6.89E+14	448	469	86
5 passes	0.3	153 ± 3	8.12E+14	441	460	89
6 passes	0.31	156 ± 2	7.36E+14	459	480	85
7 passes	0.34	158 ± 2	6.32E+14	447	468	88
8 passes	0.25	157 ± 1	4.09E+14	477	498	88

***% Reduction of Area**

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