Change of geometry of ECAP channel to increase deformation intensity by SPD process AlMn1Cu alloy

Stanislav Rusz*, Lubomir Cizek*, Stanislav Tylsar*, Michal Salajka*, Jan Kedron*, Karel Malanik**

*VSB – Technical University of Ostrava, Faculty of Mechanical Engineering, CZ 708 33 Ostrava Poruba, Czech Republic
** Research Institute of Iron and Metallurgy Dobra, CZ 738 01 Dobra, Czech Republic
stanislav.rusz@vsb.cz, lubomir.cizek@vsb.cz, stanislav.tylsar@vsb.cz, michal.salajka@vsb.cz, jan.kedron@vsb.cz, malanik@vuhz.cz,

The article presents a simulation of the ECAP process with new geometry of horizontal channel, which increases substantially its efficiency. Process ECAP, based on severe plastic deformations, is at present developed in great detail. Semi-products with UFG and NANO structure, particularly made of non-ferrous metals, are used in aviation, in electrical and automotive industries, as well as in medicine. Achievement of UFG structure requires higher number o passes through the forming tool, which greatly limits use of the ECAP process in practice [1]. Efficiency of the SPD process is low. Design of the channel was modified. A helix was built into horizontal part of the channel with higher angle of lead, which enables much greater distortion of materials during individual passes. This modification also induces a counter-pressure in the channel, which increases flow stress in forming process [2]. This leads to a more uniform deformation in the whole volume of the formed semi-product, and consequently to substantial increase in homogeneity of structure in the formed semi-product.

At the same time new ECAP tool was manufactured with this modification of design and it was built into the forming device itself. Mathematical simulation based on the program SimufactForming was used for calculation of deformation intensity and strain intensity at individual passes through the ECAP tool. These values were continuously compared with the values achieved with classical geometry of the ECAP tool. Altogether 6 passes were performed through the forming tool. It was also performed experimental verification of the results of simulations. He evaluated the influence of passage on the size of the hardness and metallographic analysis of samples taken.

At first part a mathematical simulation based on the program SimufactForming was used for calculation of deformation intensity and strain intensity at individual passes through the ECAP tool with new geometry- helix matrix in horizontal part of channel. Results of simulations are given in Fig.1.

As experimental materials AlMn1Cu alloy for ECAP process with new geometry was used. Influence number of passes on stress values is given in Fig.2 [3].

Metallographic analysis on light microscopy NEOPHOT 2 was performed. Results of metallographic analysis of samples AlMn1Cu alloy are shown in Fig.3.

Results from the simulations and from experiments have confirmed the original assumption of substantial increase of efficiency of the ECAP process with new geometry.

References

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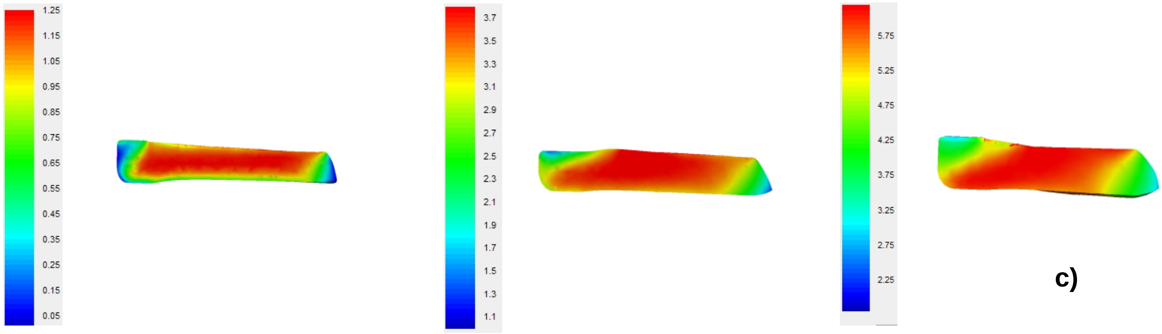
Figures



a) b) c)

Fig.1. Simulation of new ECAP geometry (helix matrix) - intensity of deformation a) after 1st first pass, b) after 3rd pass, c) after 5th pass

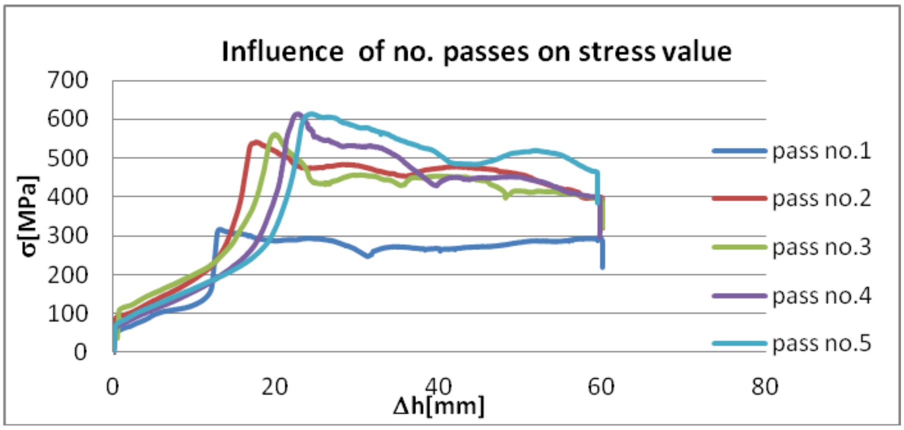
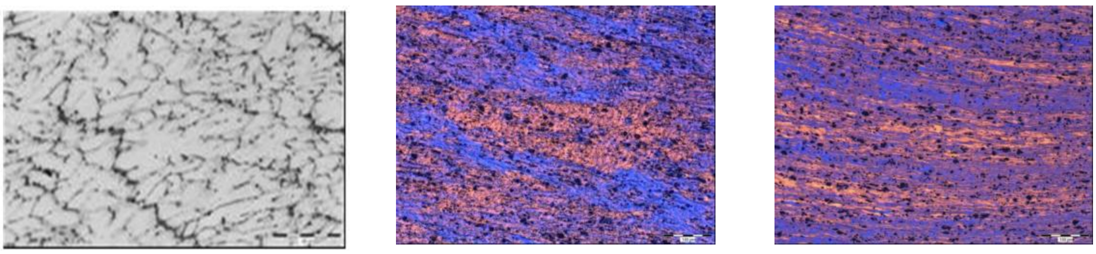


Fig.2. Stress – strain curves obtained in the ECAP process with changed geometry tool



a) b) c)

Fig.3. Results of metallographic analysis a) initial state, b) 3rd pass, c) 5th pass