HUMAN CAPITAL
NATIONAL COHESION STRATEGY

INSTITUTE OF METALLURGY
AND MATERIALS SCIENCE
Polish Academy of Sciences

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UNION

Oxford Instruments EBSD Symposium
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Early stages of recrystallization in ultra fine-grained AA1050 aluminium alloy

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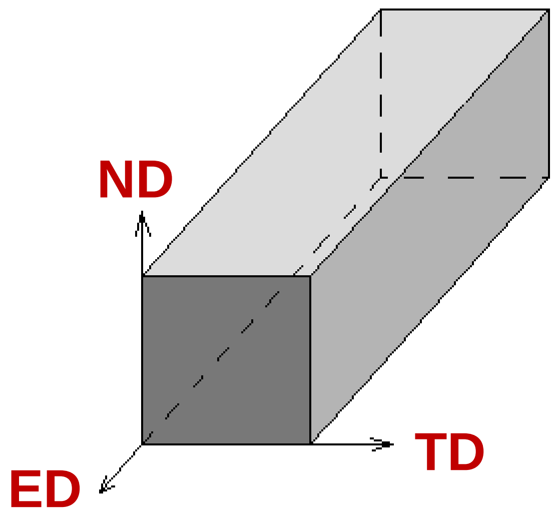
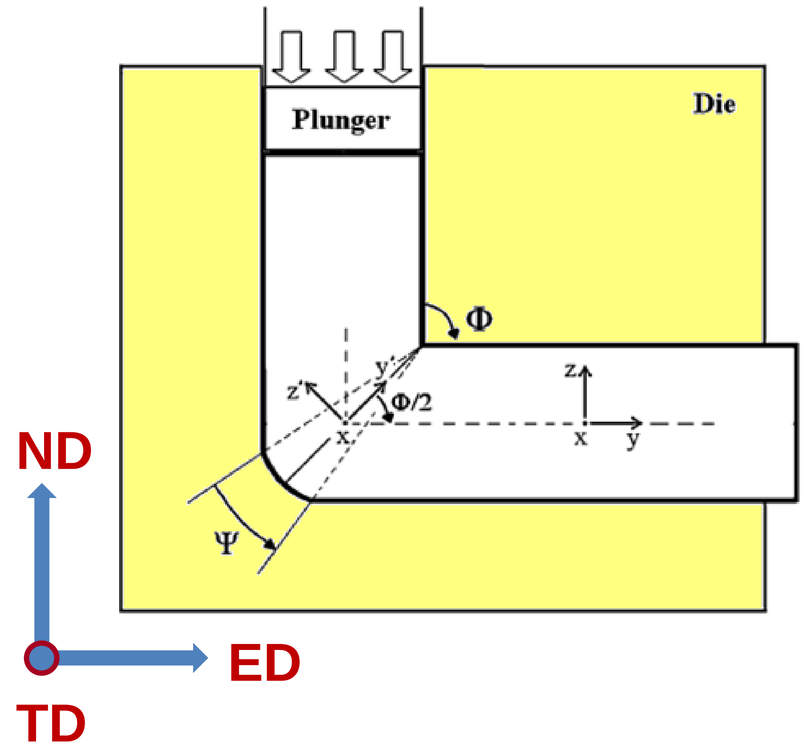
Billet

10 x 10 x 70 mm



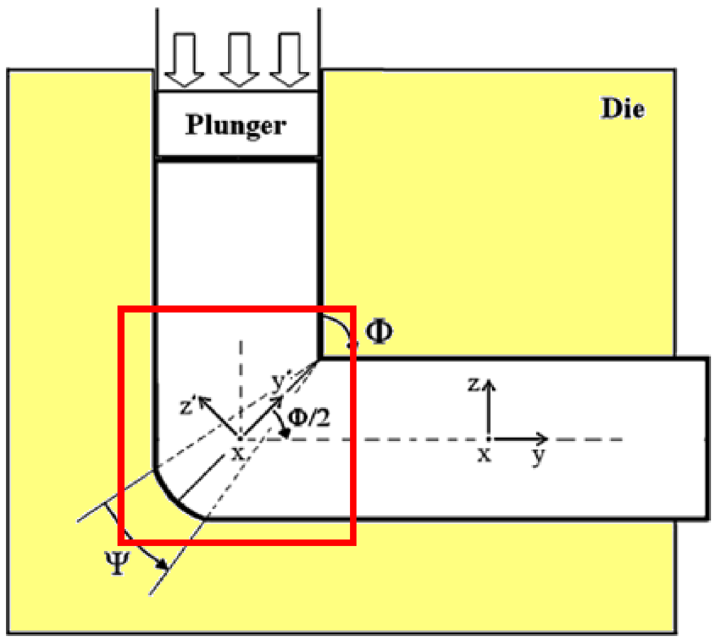
Scheme of ECAP die

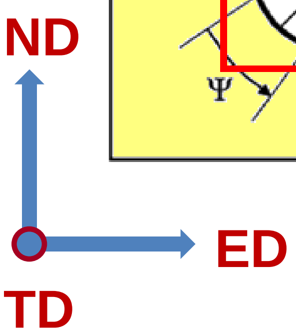


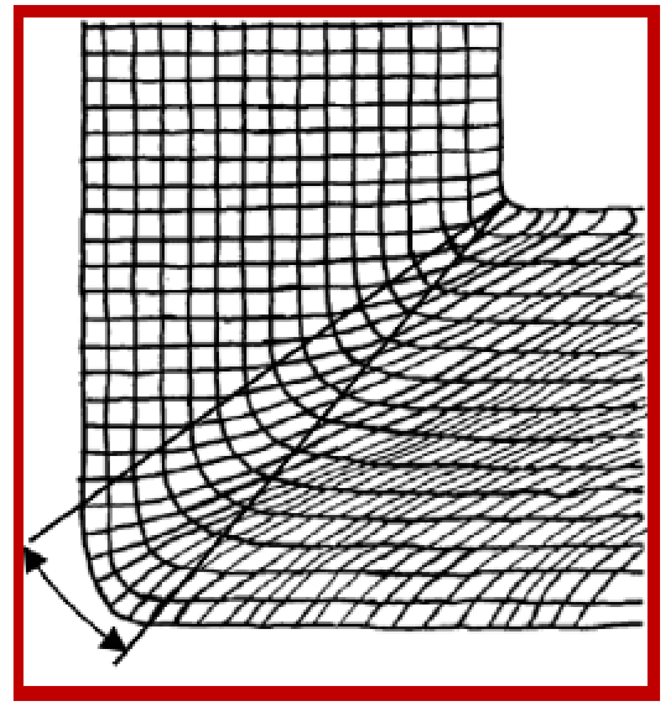
- ECAP is one of the SPD techniques
- It allows to obtain ultra fine-grained structure
- Beneficial mechanical properties
- Problem with ‘thermal stability’ of structure

Equal Channel Angular Pressing (ECAP)

Scheme of ECAP die







The ECAP-deformed material contains a structure of flat grains

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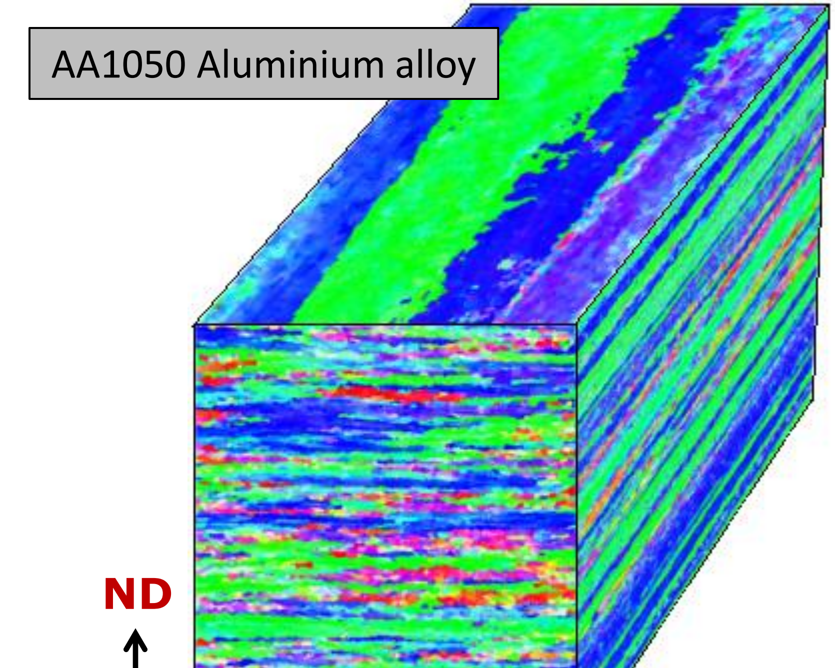

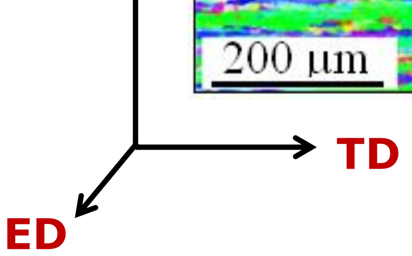

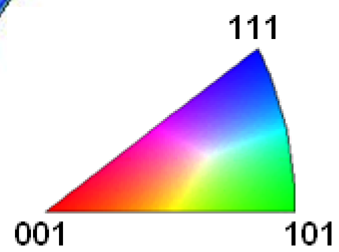

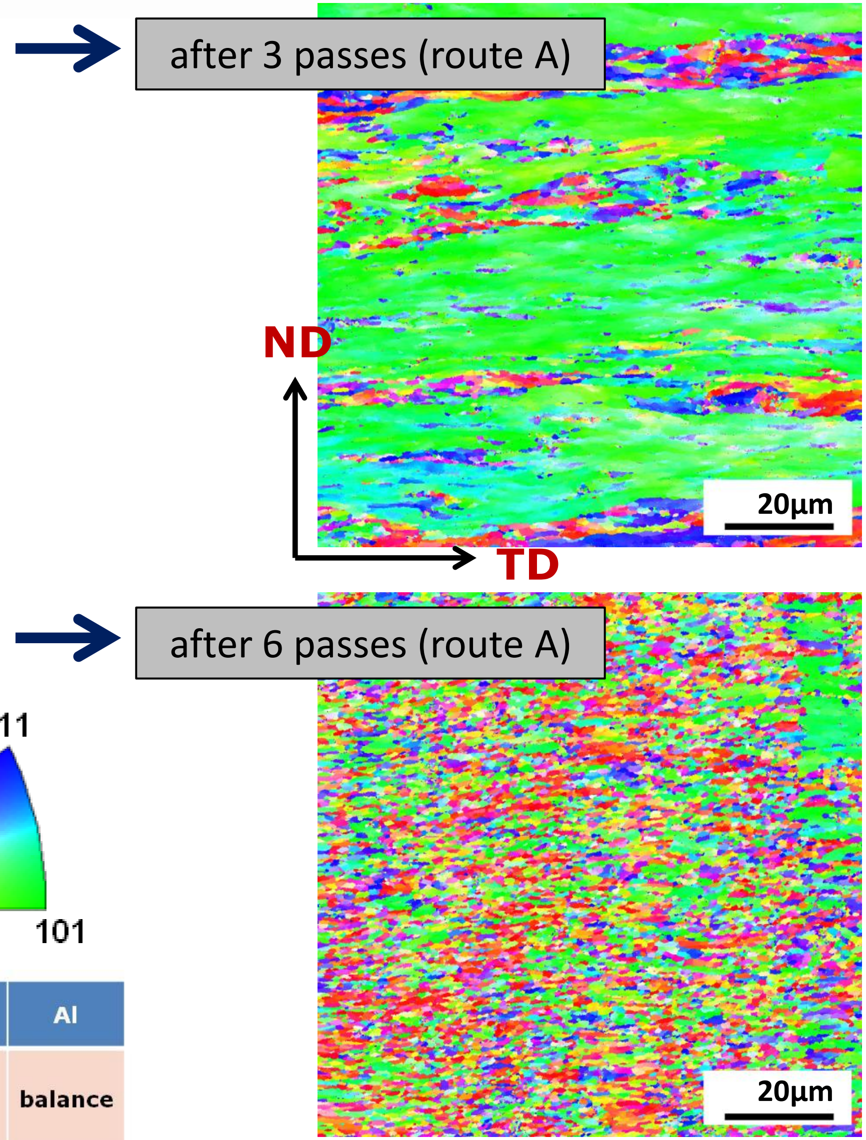

element	Si	Fe	Cu	Mn	Mg	Zn	Ti	Al
content, % wt.	0,25	0,40	0,05	0,05	0,05	0,07	0,05	balance

Equal Channel Angular Pressing (ECAP)

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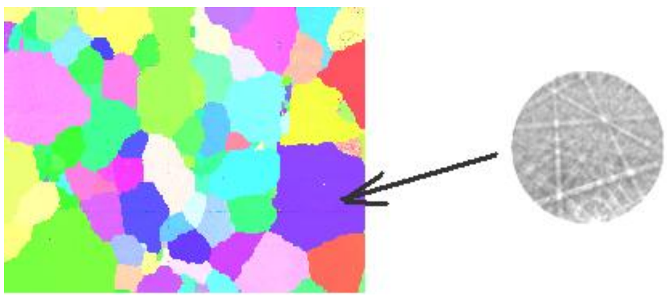
Quanta 3D FEG - FEI

Parameters of experiment

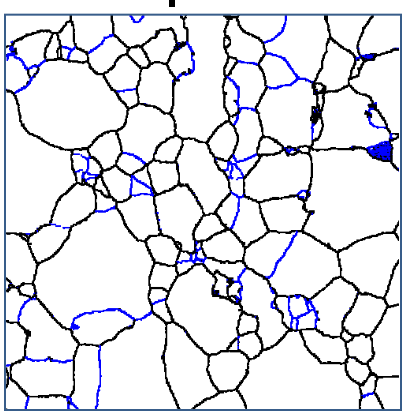
- tilt 70°
- working distance 10-12
- accelerative voltage 15 keV
- step size 100 nm
- EBSD map size 1000x1000 pcs

SEM/EBSD → Software to collect data

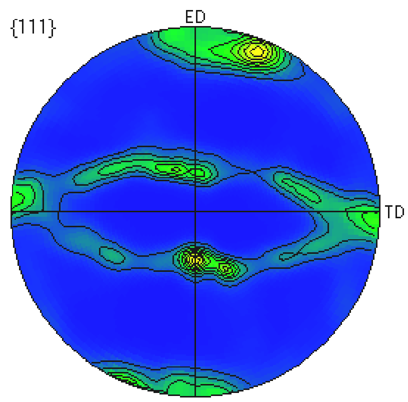


Software to analyze data
(HKL Channel 5)

Morphological aspects



Crystallographical aspects



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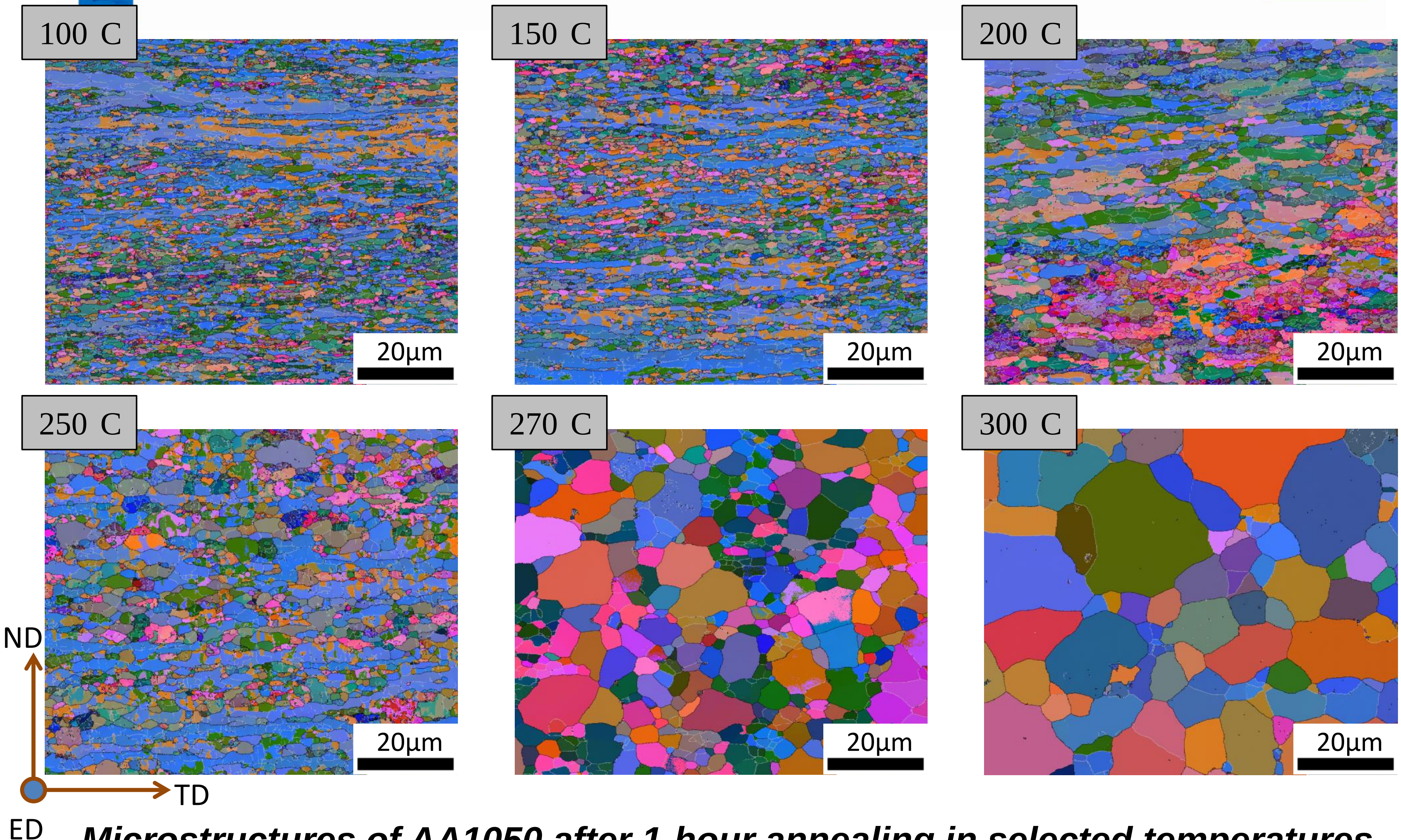
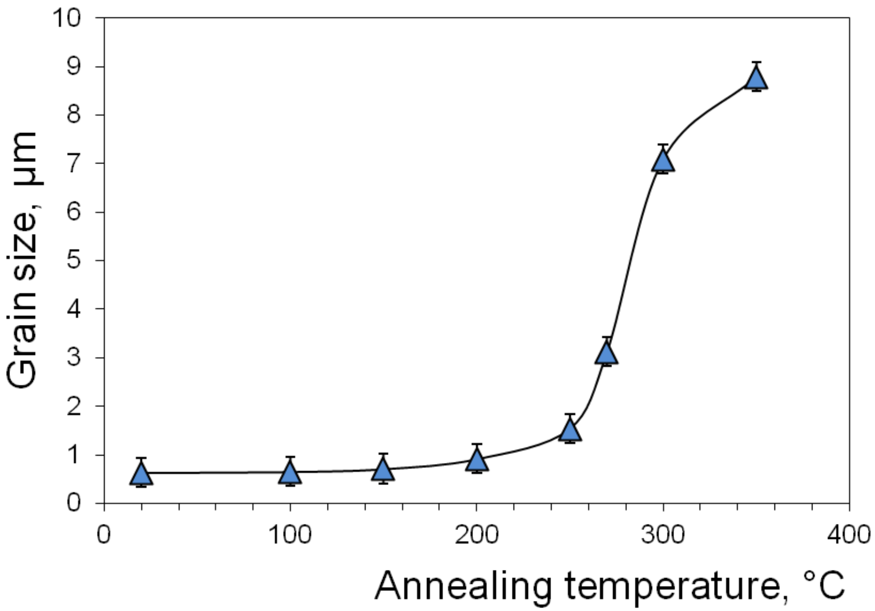
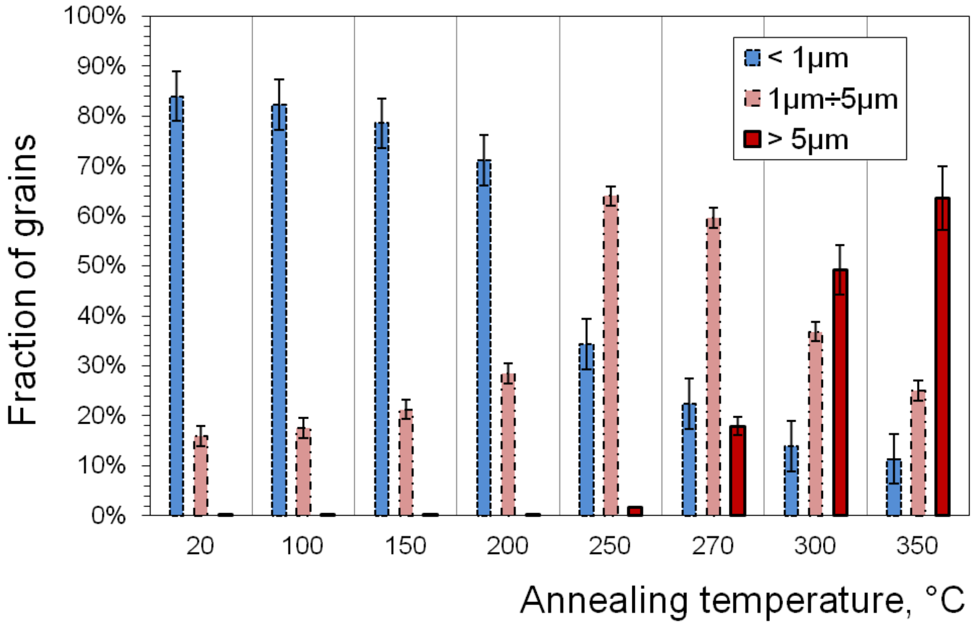


Microstructures of AA1050 after 1-hour annealing in selected temperatures

Analysis of data from EBSD maps

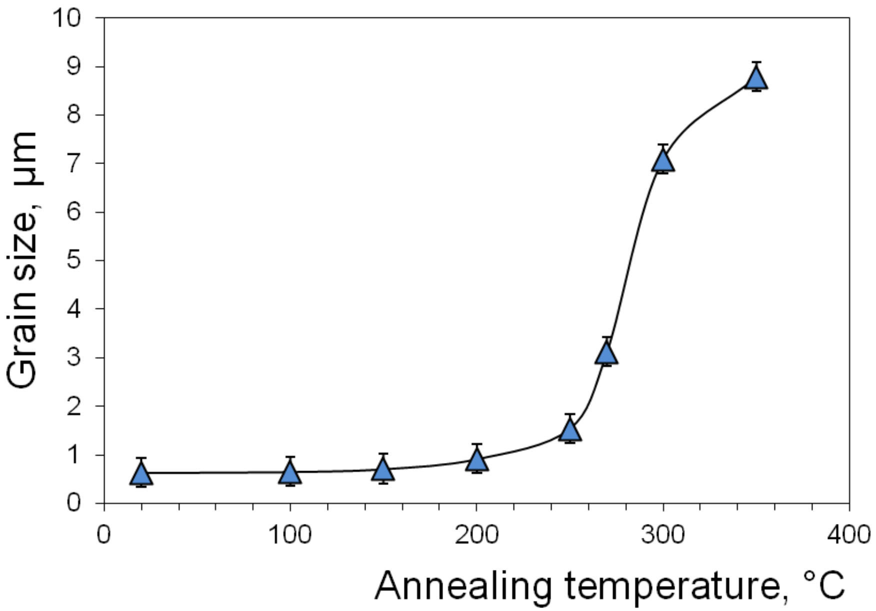




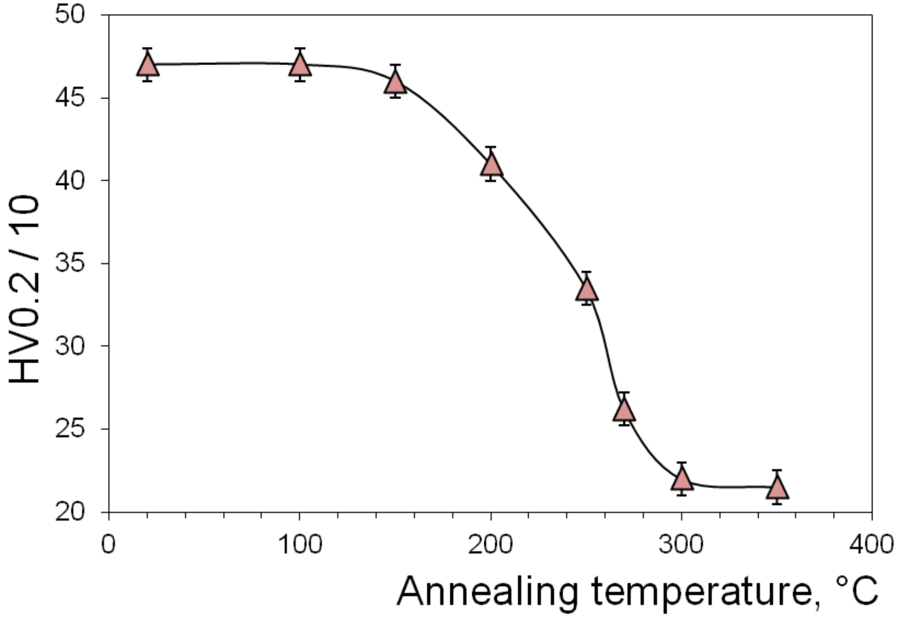
Change in average grain size with annealing temperature, for 1h treatments of AA1050 alloy

Change in grain size distribution with annealing temperature, for 1h treatments of AA1050 alloy

Analysis of data from EBSD maps

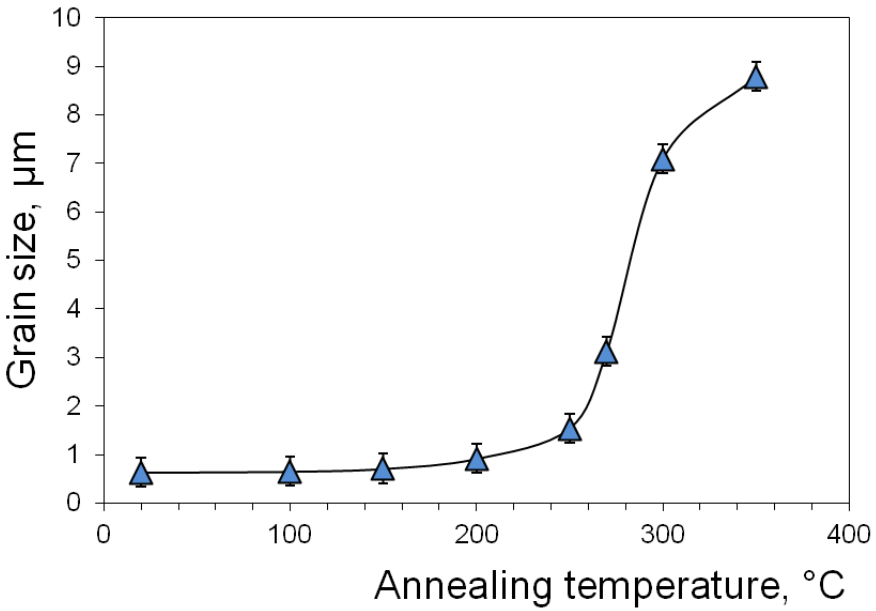


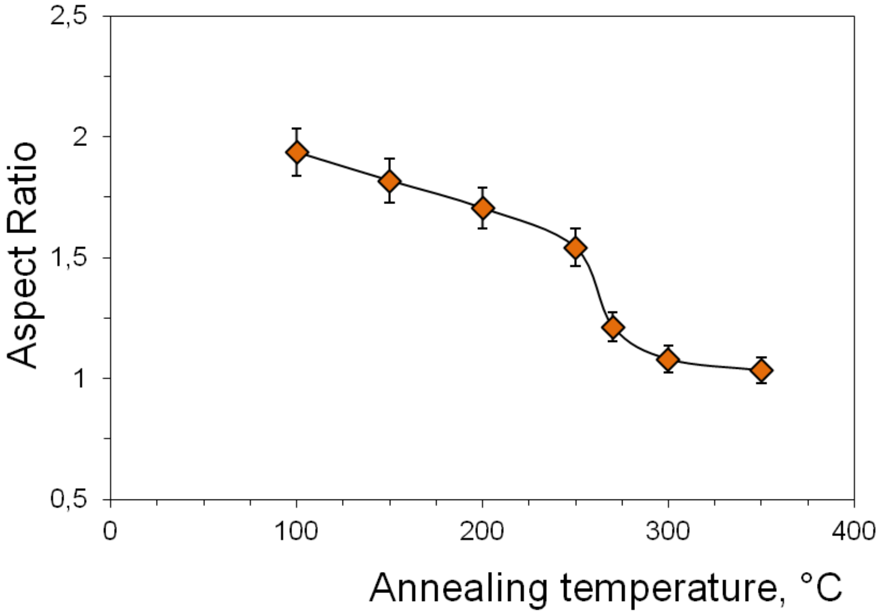
Change in average grain size with annealing temperature, for 1h treatments of AA1050 alloy



Change in microhardness with annealing temperature, for 1h treatments of AA1050 alloy

Analysis of data from EBSD maps





Change in average grain size with annealing temperature, for 1h treatments of AA1050 alloy

Change of aspect ratio in TD with annealing temperature, for 1h treatments of AA1050 alloy

Analysis of data from EBSD maps

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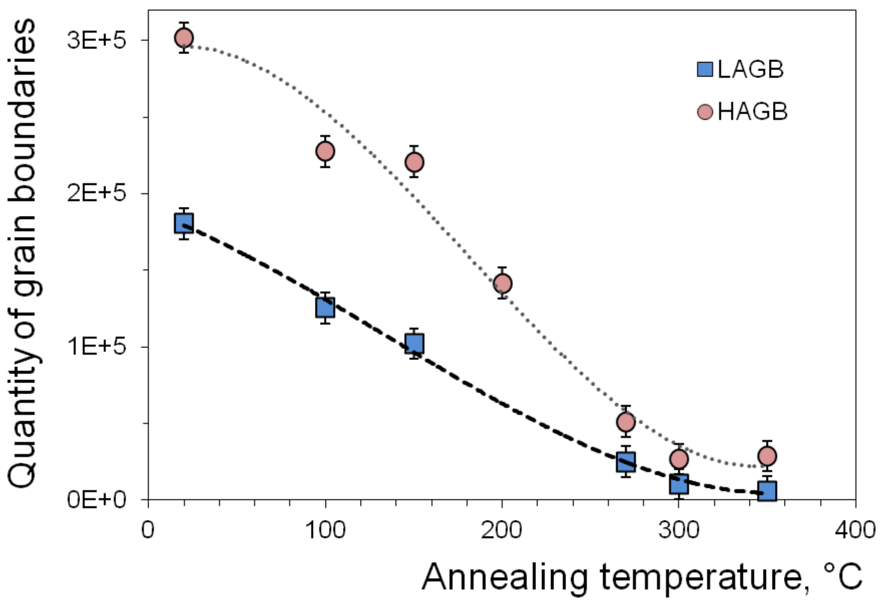

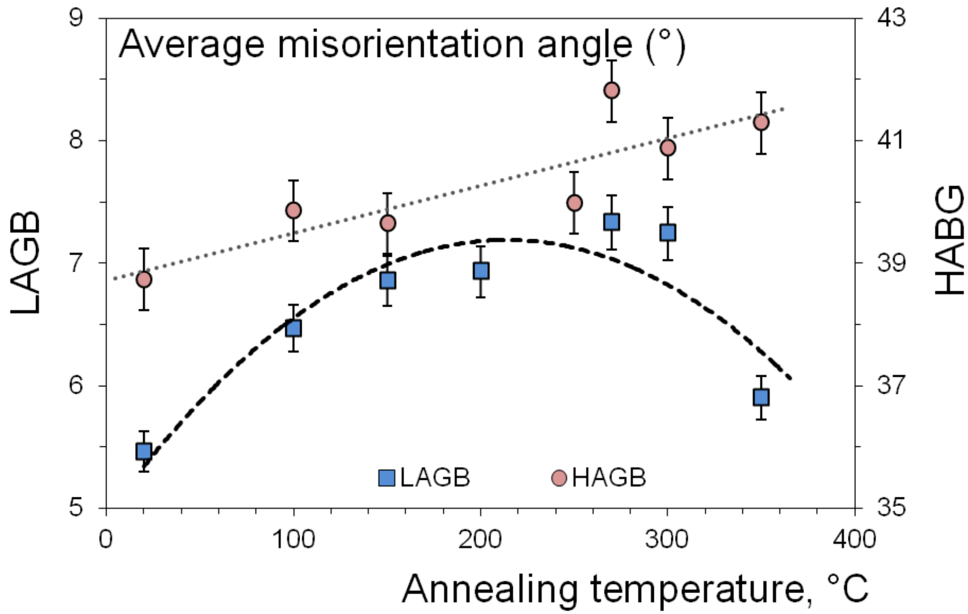

Changes in quantity of grain boundaries (LAGB and HAGB) with annealing temperature, for 1h treatments of AA1050 alloy

Changes in average misorientation angle of LAGB (<15) and HAGB (≥15) with annealing temperature, for 1h treatments of AA1050 alloy

Analysis of data from EBSD maps

Summary

- ECAP process up to 6 passes, according to route A, leads to homogeneous fragmentation of microstructure of the aluminum alloy AA1050. The structure of flat grains was strengthened by small grain size and high density of grain boundaries.
- Analysis of structure changes associated with the annealing process leads to the conclusion that for recrystallization temperature of 270 C ability of keeping homogeneous structure of fine grained particles (in nanometer range) is quite problematic.
- At 270 C, new recrystallized grains appear and their shape is close to spherical.
- Significant fraction of fine grains is maintained up to 1h annealing at 200 C. For higher annealing temperatures (above 240 C) is observed the rapid growth of medium-size grains (1-5μm).
- For low temperatures LAGB (<15) is increased their misorientation angle with annealing temperature but above the 270 C decrease is observed.

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Thank you for your attention !