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HUMAN CAPITAL
NATIONAL COHESION STRATEGY

INSTITUTE OF METALLURGY
AND MATERIALS SCIENCE
Polish Academy of Sciences

EUROPEAN
UNION

Interdisciplinary PhD Studies in Materials Engineering with English as the language of instruction

Influence of zirconium and scandium on microstructural and textural changes of severely deformed aluminum alloys

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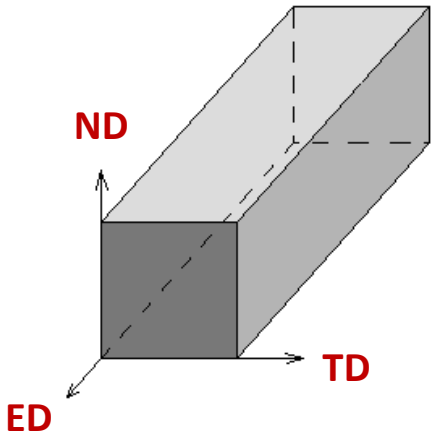
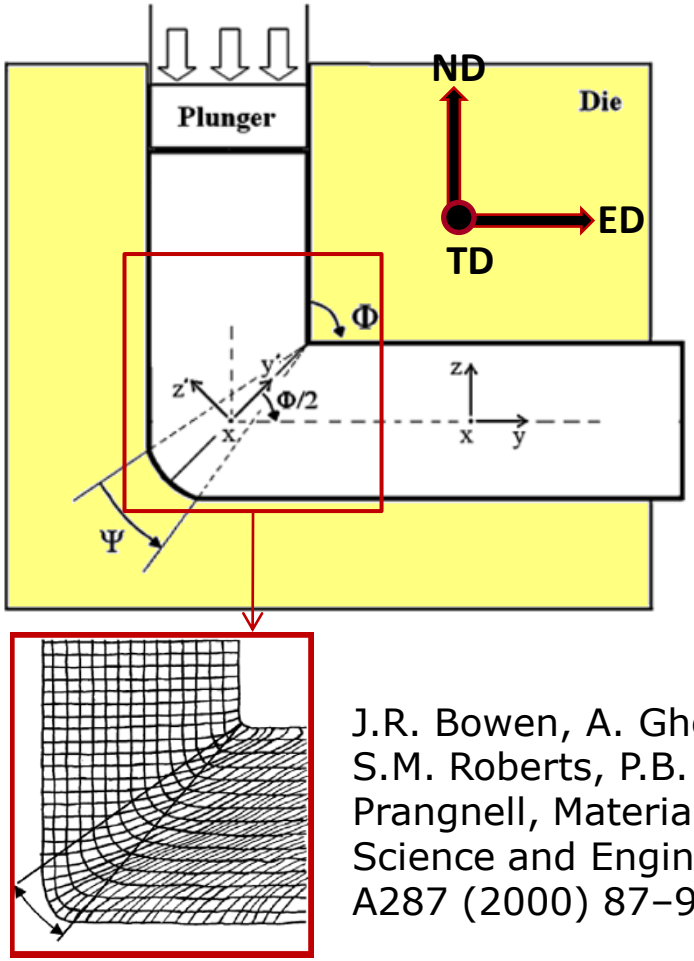
Krakow, 2012

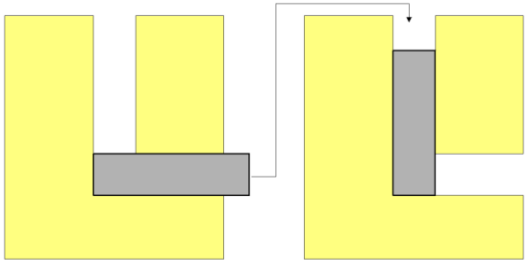
Severely deformed aluminum alloys by ECAP

Billet 10 x 10 x 70 mm





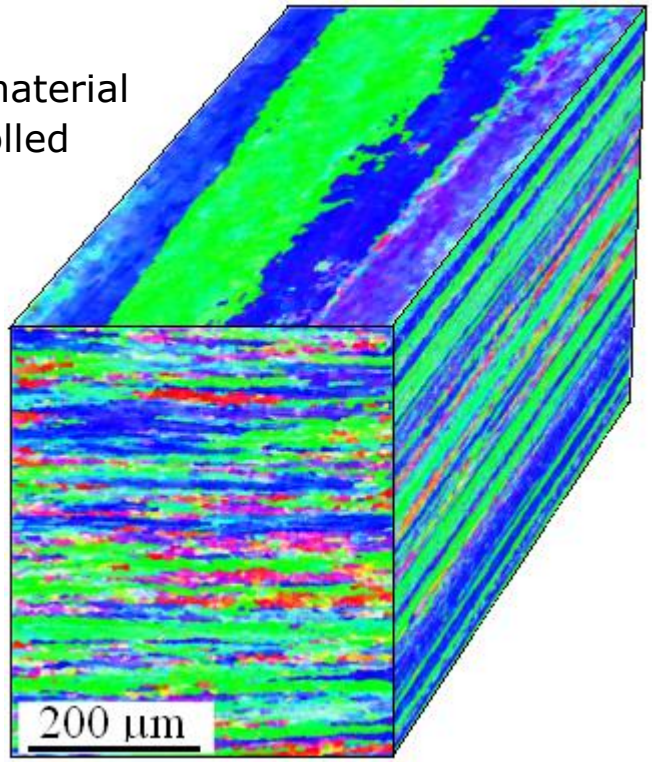
Route A - without rotation between each pass

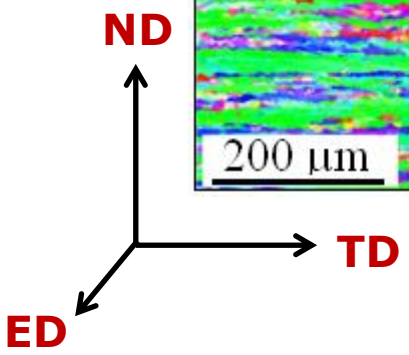


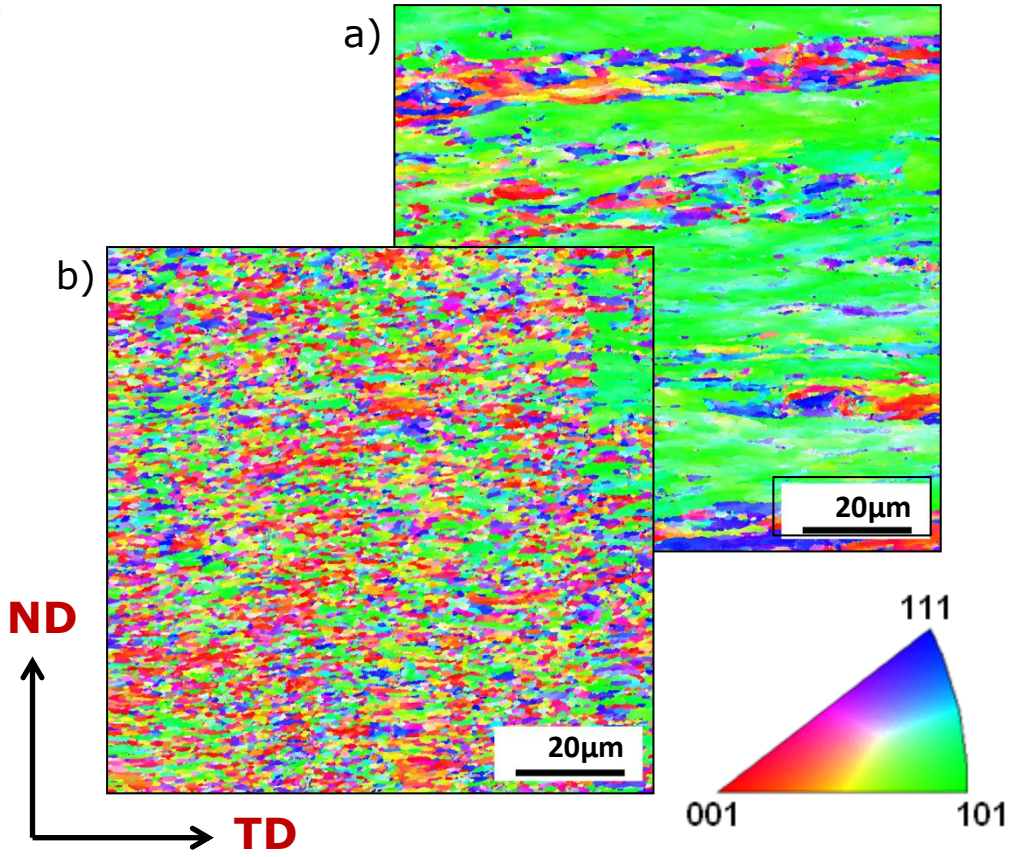
J.R. Bowen, A. Gholinia, S.M. Roberts, P.B. Prangnell, Materials Science and Engineering A287 (2000) 87–99

Severely deformed aluminum alloy AA1050

Initial material – hot rolled

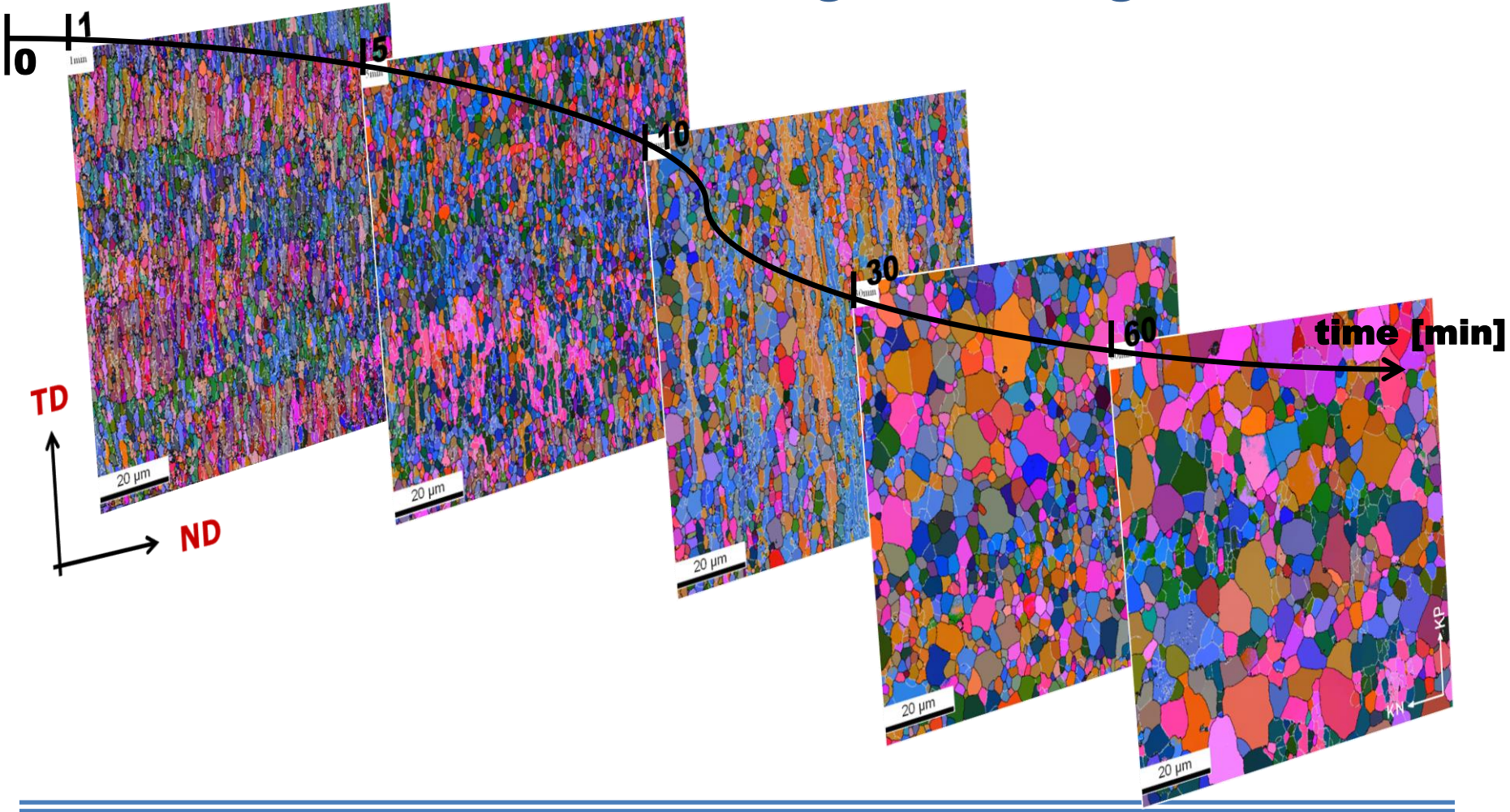




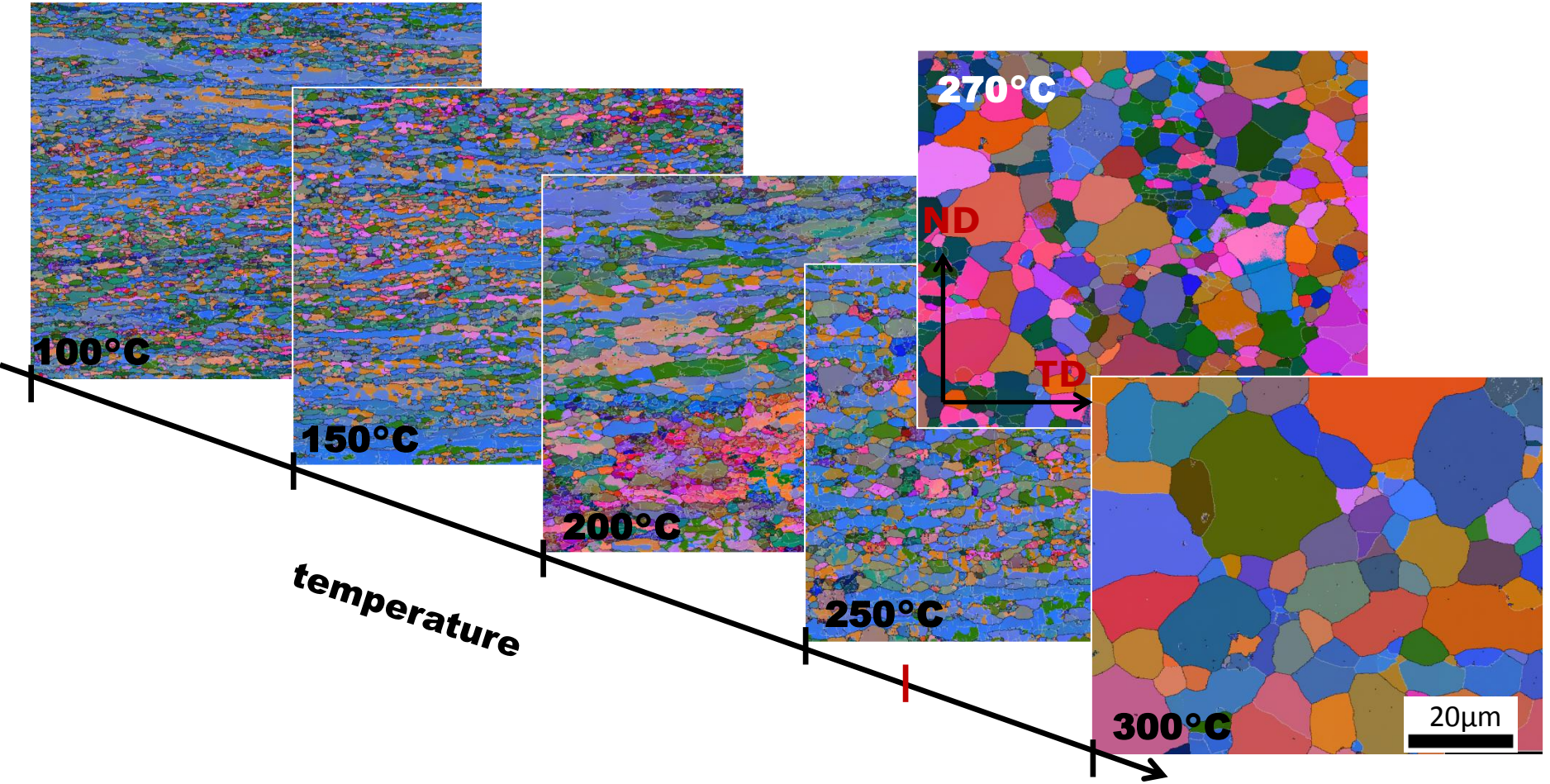


Material after ECAP a) 3 passes b) 6 passes

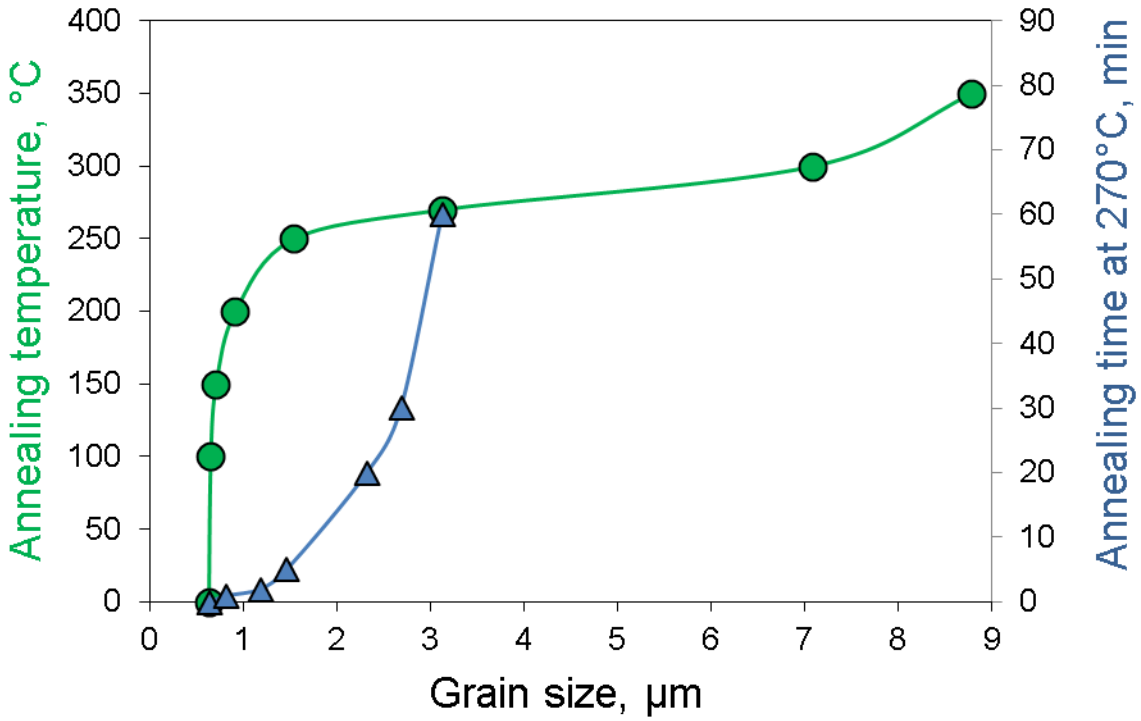
Structure evolution during annealing at 270°C



Structure evolution during 1-hour annealing

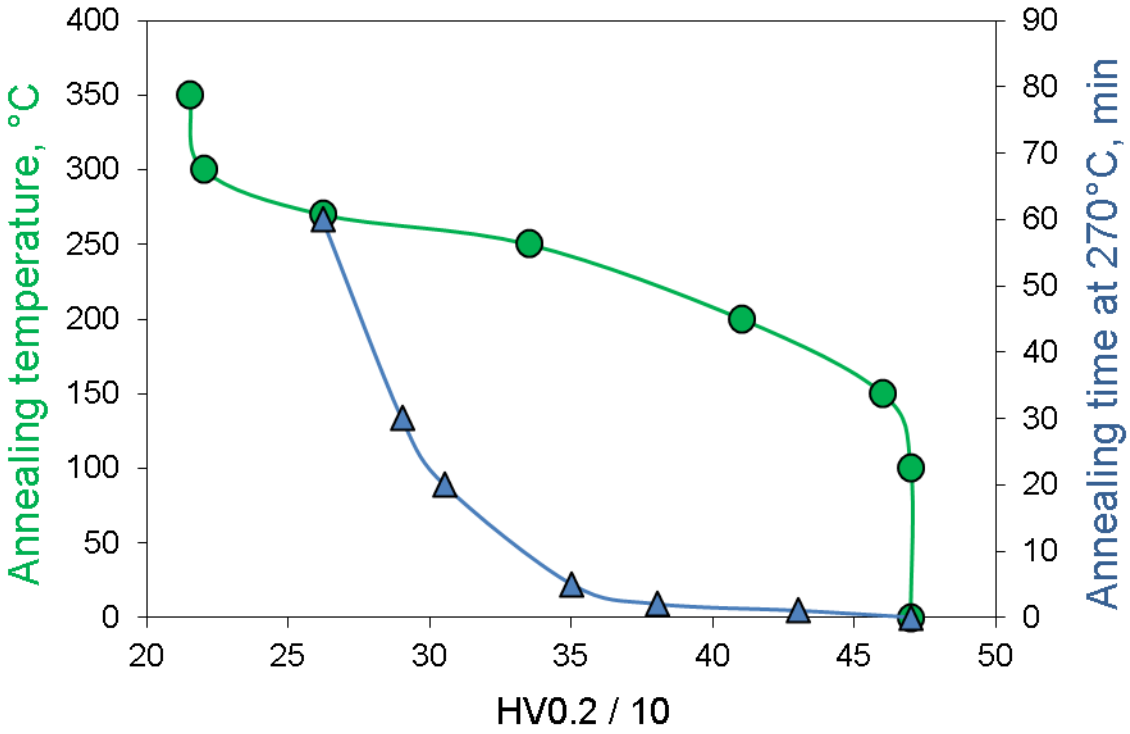


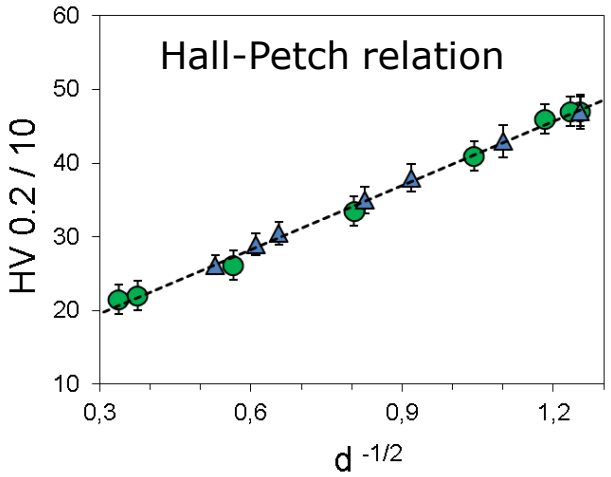
Changes of grain size during recrystalization



Results of average grain size for aluminium alloy AA1050 deformed into ECAP (6x via route A) and: a) annealed for 1-hour at selected temp., b) annealed at 270°C by 1 to 60 min.

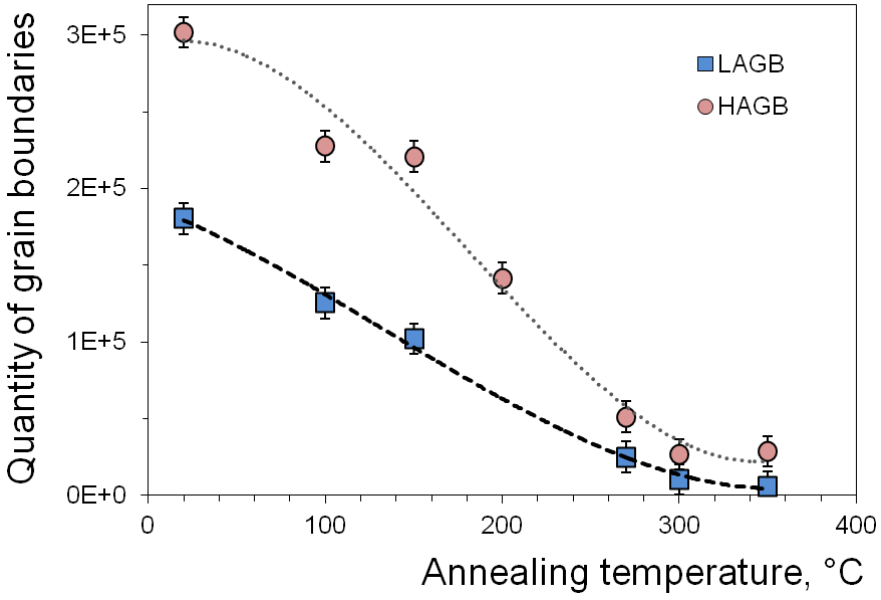
Change of microhardness during recrystalization

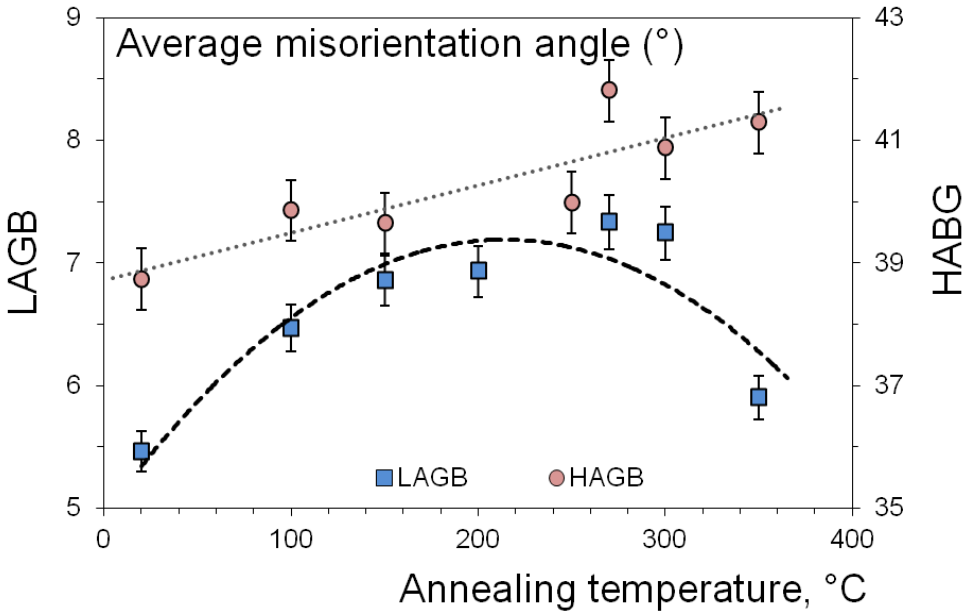




Results of microhardness for aluminium alloy AA1050 deformed into ECAP (6x via route A) and: a) annealed for 1-hour at selected temperatures, b) annealed at 270°C from 1 to 60 min.

Grain boundaries evolution during 1-hour annealing





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.

Summary

- ECAP process up to 6 passes, according to route A, leads to homogeneous fragmentation of microstructure of the aluminium 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 lower temperature LAGB (<15) increase their misorientation angle with annealing temperature but above the 270 C decrease is observed.

Future studies

- Continued studies with AA1050 in range of texture changes during recrystalization
- Microstructural and textural changes of materials deformed by ECAP and annealed for 1 hour at selected temperatures will be carried out for alloys: AA3004 (in progress), Al-Zr, Al-Mg-Zr, Al-Sc (optional), actions:
  - ✓ Processing material through ECAP die up to 6 passes via route A
  - ✓ 1-hour annealing at selected temperatures
  - ✓ EBSD/SEM local orientation measurements
  - ✓ Data analysis with Channel 5 software by HKL Company
- Microhardness measurements
- Microstructure characteristics with TEM
- Global texture measurement with X-ray diffractometer
- Developing a crystallographic decription of texture transformation process taking place during recrystallization