МИНИСТЕРСТВО ОБРАЗОВАНИЯ И НАУКИ РОССИЙСКОЙ ФЕДЕРАЦИИ

ФЕДЕРАЛЬНОЕ ГОСУДАРСТВЕННОЕ БЮДЖЕТНОЕ ОБРАЗОВАТЕЛЬНОЕ
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В сборнике помещены труды молодых исследователей, участников Международного форума-конкурса «Проблемы недропользования» (19-21апреля 2017 г.). Материалы сборника представляют интерес для широкого круга исследователей, ученых, педагогов, специалистов, руководителей промышленных предприятий и предпринимателей, работающих в области поиска, разведки, добычи и переработки полезных ископаемых.

The Volume contains works of young researchers-participants of International Forum of Young Researchers «Topical Issues of Subsoil Usage», which was held at the St. Petersburg Mining University from the 19th to 21st April 2017. The Volume can be of great interest for a wide range of researchers, scientists, university lecturers, specialists and managers of industrial enterprises and organisations as well as for businesspeople involved in exploration, prospecting, development and processing of minerals.

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refinement in comparison with conventional equipment. Severe plastic deformation process was carried out at ambient temperature while the deformation rate was constant 2 mm/s. To lower the friction between a sample and ECAP die, the molybdenum disulphide (MoS2) lubricant was used.

Table 1. Chemical composition (in wt. %) of the Al-3%Mg aluminium alloy

Mg	Fe	Si	Cu	Ti	Al
2.86	0.07	0.07	0.01	0.01	rest

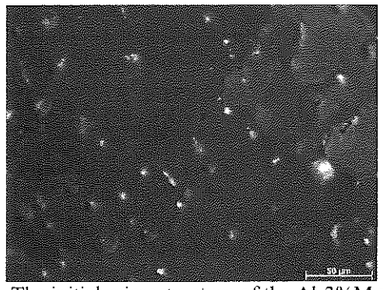

Fig. 1. The initial microstructure of the Al-3%Mg alloy

The representative light optical microscope images showing the microstructure of Al-3%Mg alloy in the as cast state are presented in the Figure 1. It is clearly visible that the microstructure of the alloy can be characterized as fine dendritic and coarse grained. Moreover, it can be also observed that a large majority of the β-phase is distributed in the inter dendritic region and on the grain boundaries as a result of the non-equilibrium solidification. The initial state microstructure consists of four phases α-Al primary phase – matrix of an alloy, Al_3Mg_2, Mg_2Si and Al_3Fe.

a) b)

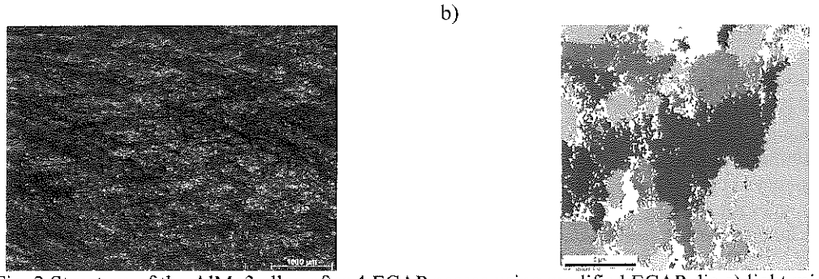

Fig. 2 Structure of the AlMg3 alloy after 4 ECAP passes using modified ECAP die a) light microscope, b) EBSD image

Based on the metallographic analysis presented in Figure 2a it can be concluded that the size of individual grains cannot be clearly measured because of the presence of a slip, shear and micro-shear bands which forms the band-like microstructure. The EBSD orientation map (Figure 2b) shows that the obtained microstructure becomes fine-grained with an average grain size of about ~ 1μm. However, it can be also seen that some grains/subgrains have a size of about 300 nm.

Table 2. Results of Vickers hardness measurements

As cast	~ 45 Hv
Precipitation treated	~ 63 Hv
As cast 4 ECAP passes – modified (90°) ECAP die	~ 121 Hv
Precipitation treated 6 ECAP passes – conventional (120°) ECAP die	~ 130 Hv

Hardness measurements shows that using an ECAP process has meaningful influence on the properties of the material. It can be observed that there is a significant improvement in hardness of the material for both investigated cases. This increase in mechanical properties is due to the grain refinement.

Summary

In this study, we showed that Equal Channel Angular Pressing method can be a very promising metalworking process which results in a significant increase in mechanical properties of the materials. Moreover, it is shown that the modification of the ECAP equipment can be a promising way to introduce more strain into the material in a single pass.

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RADOSŁAW ZAJDEL, KRZYSZTOF SOŚNICA
Wroclaw University of Environmental and Life Sciences

WEB-APPLICATION DEVELOPMENT FOR VISUALIZATION AND ANALYSES OF GNSS ORBIT VALIDATION RESULTS BASED ON SLR DATA

Satellite Laser Ranging (SLR) is one of the oldest satellite observation technique connected with direct monitoring of the objects orbiting around the Earth. Since 1964, when first observations of the low-orbit satellite Beacon-B started, SLR has moved forward with a huge technological leap binding with the increase of both a precision of observation and accuracy. Nowadays, SLR technique is a foundation of satellite observation techniques, which generates the most accurate products of precision range up to few millimetres. Estimating the distance to some orbiting objects based on SLR observations generates huge and powerful source of data, which in indirect way is used to describe our planet. SLR provides highly accurate gravity field models, especially the low-degree coefficients, and the best coordinates of the geocenter. It can also be used for geodynamical and geophysical phenomena studies or determination of temporal gravity field changes. Last but not least SLR has a substantial contribution to the definition of the International Terrestrial Reference Frame with a reference to the scale and origin of the frame determination.

Initially the main field of interest of SLR was to monitor scientific research satellites primarily on the low Earth orbits, such as LAGEOS or Starlette which were dedicated to this technique. Over time, next generations of other satellites, such as the satellites of the Global Navigation Satellite Systems (GNSS) became equipped with a special laser retro-reflectors arrays (LRA) which make it possible to track satellites by the laser beam. Things are no different for the newly designed GNSS satellites which consistently mount LRAs on their boards. This is remarkable in the light of new possibilities that it creates. First of all SLR became the independent technique, providing valuable information about actual accuracy and the quality of orbit models. Moreover, it allows combining SLR and GNSS techniques using a co-location in space. The co-location is independent of the systematic errors caused by local ties on the station side which in near future can play a fundamental role in strengthening of the ITRS realizations. Improving the quality of GNSS orbits and the opportunity to eliminate one of the greatest source of GNSS microwave scale error: uncalibrated antenna phase centre offsets, seems to be the most interesting in this issue.

With reference to the merits of GNSS microwave and SLR techniques integration as well as the challenges of the future satellite systems realizations, I have created a web-application, whose main task is to allow the user to analyse the results of multi-GNSS orbit validation of microwave orbits using SLR data. By multi-GNSS it means that it provides some information about four different global and regional navigation satellites systems supplied with LRAs: GLONASS, Galileo, Beidou, QZSS. The functionalities of the web-application let store archival and continuous cumulate near-real time data, visualize the results of the validation and enable the user to analyse them in various variants. The web-application assures independent source of information about the actual quality of GNSS satellites orbits tracked by SLR and the general spacecraft condition. Moreover, archive data analyses allow the user to search for dependencies between many factors involved in SLR observations and the final residuals values such as station equipment, satellite characteristics, and the angles associated with the mutual location of a station, a satellite and the Sun at the moment of observation. The results of the above analyses can be a basis for modelling of the systematic errors imposed on validation results from both, GNSS satellites orbits and SLR stations. Reports and conclusions coming from the service may contribute to the effective growth of the user number of navigation satellites systems especially in Precise Point Positioning (PPP) technique, sensitive to the radial component error of the orbit. Near-real time functionality can alert about anomalous behaviour of a specific satellite based on long-term archival characteristics. In that way, observations to a satellite that seems to be faulty could be excluded from processing.

The web-application uses altogether reprocessed data from 39 SLR stations observing 49 satellites: 14 Galileo, 4 BeiDou, 1 QZSS, 30 GLONASS, which covers the time range from the 1st January, 2014. It generates