26 August, 2016

NTNU
Faculty of Engineering Science and Technology
Department of Engineering Design and Materials

Reviewer's report on the Dissertation entitled "Study of novel magnesium alloys with controlled microstructure and texture" by **Daria Drozdenko** prepared for partial fulfilment of the requirements for the degree of Doctor of Philosophy at the Department of Physics of Materials, Charles University in Prague.

As the race for better material performance is never ending, so do the attempts to develop lighter and lighter structural materials with higher and higher strength and improved ductility. Magnesium-based alloys are admittedly the lightest structural materials having a highest potential for "green mobility" applications. These are complex multi-component, multi-phase systems having a hierarchical microstructure involving all variety of scales from atomistic to macroscopic. Their physical, mechanical and chemical properties are intimately interconnected and should be considered simultaneously, ideally using multiple complementary technologies and experimental techniques. The dissertation of Daria Drozdenko is centred on comprehensive characterization of the microstructure and the mechanical behaviour of magnesium–based alloys. The judicious use of a contemporary acoustic emission (AE) technique adds one more dimension to the in-situ characterization of underlying deformation mechanisms.

Entering the boosting area of research on the mechanical behaviour of advanced magnesium alloys, the author builds her arguments across five well-crafted chapters including the Introduction and Conclusions. The introductory Chapter 2 provides a brief survey of the relevant literature highlighting current trends of the mechanical behaviour, structure-properties relation in Mg and its alloys and fundamentals of the acoustic emission method. *The background, existing* work in this area, initial investigation methods, results to date and discussion are presented consistently with the results obtained in the thesis. The state-of-the-art research in the field of the deformation behaviour of Mg and its alloys is covered comprehensively. Chapter 3 summarizes the goals of the dissertation while Chapter 4 and advocates the experimental techniques used and provide the readers with necessary experimental information. Experimental details for the specimen preparation, mechanical testing and analytical methods used are are described in Chapter 5 describes and discusses the experimental findings scrupulously in in every possible detail. The chapters including sub-chapters are logically and conceptually interconnected that can be easily

followed by a reader.

In the Chapter 3, Daria states the aims, concerns, methods and problematic guiding her work in a concise manner. Although the aim of the thesis is formulated in a very general manner as to "a thorough description of the slip- and twinning activity in novel Mg alloys with controlled microstructure and texture", the more focused objectives are stated quite clearly and these include (i) obtaining a comprehensive set of AE data for specific deformation mechanisms, which were activated during compression loading of Mg single crystals. (ii) investigation of active deformation mechanisms with special attention to twinning-detwinning in extruded Mg alloys during pre-compression followed by reverse tensile loading and (iii) analysis the texture factors induced through different rolling processes on the deformation behavior of Mg alloys. Although *the topic itself is "classical"* in literature, *but* it has not been covered systematically as yet and therefore is still very handy. The novelty of this work is ensured with careful selection of the materials and processing techniques used combined with contemporary methods employed for structural characterization in parallel with the in situ AE technique providing new insights into the physics underlying the deformation behaviour of Mg alloys.

Chapter 4 describes the experimental procedures adequately and concisely but to the extent sufficient for full understanding of the results and reproduction. The approach ensured that the experiments are original, carefully designed and mastered by Daria to high standards, meeting the goals of the present thesis. Further details of the experiments are given through the text with proper references to the previous works.

Key results are described in Chapter 5 meticulously. The detailed analysis of the complexity of the twinning –detwinning behaviour, which occurs concurrently with dislocation slip possibly activated in different systems is the main challenge faced by the author. Therefore, Daria Drozdenko invested significant efforts into design of experiments in such a way as to highlight and emphasize certain well-defined deformation modes, which was very rewarding in that this enabled the author to obtain consistent and well-argued results. It particularly, the result which is noteworthy is that both twining and detwinning processes involve boundary mobility which is independent of the grain size. Another result which is conceptually important for future modelling of the twinning behaviour in

materials is that the twin nucleation is strongly grain size dependent. This point is often missed in modern crystal plasticity models. The question, which immediately arises at this important point is how this result agrees with the CRSS concept for twinning? The mechanistic CRSS does not assume any explicit grain size dependence for the twinning nucleation while the experiments undoubtedly demonstrate the opposite trend.

The results and conclusions are well disseminated in several peer-reviewed publications and are well received in the scientific community. The reviewer had several opportunities to attend the presentations, which Daria Drozdenko delivered during international conferences, e.g. IPSMA-2014 and Magnesium-2015. The manuscript is well organised and sharply focused with a high standard of presentation in good English and carefully selected illustrations. The thesis demonstrates undoubtedly that the candidate is highly capable of conducting independent scientific research in either academy or industry.

In summary, the dissertation by Daria Drozdenko is a highly appropriate and intellectually demanding work with well-defined aims identified within a well understood conceptual framework based on an extensive understanding of the literature. Methodology and data collection are thorough, comprehensive and innovative in many experimental aspects, particularly those related to the advanced AE method. High quality results, insightful interpretations and detailed discussion exhibit excellent higher-level cognitive skills. Analysis is rigorous leading to sound conclusions. In view of this, the dissertation deserves the highest score without even a shade of a reservation and I do recommend to the committee the thesis being accepted for further promotion and defense.

Sincerely,

Alexey Vinogradov

_____

Professor of the Department of Engineering Design and Materials
Norwegian University of Science and Technology -NTNU
Richard Birkelandsvei 2B N-7491 Trondheim – NORWAY
E-mail: alexei.vinogradov@ntnu.no
Tel: +47 735 937