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Referee's report on the Habilitation thesis of Ing. Martin Nikl, CSc. entitled

Modern Fast Scintillation Materials Based on the Doped Complex Oxides

This habilitation thesis is devoted to the research and development of crystal solid state scintillation materials based on complex oxides. These materials are crucial for the detection and monitoring of ionizing radiation, accelerated charged particles, and neutrons. They are used in fundamental physics and applied research, e.g. in medicine and industry.

The thesis is a collection of 23 papers authored or co-authored by Ing. Nikl in the years 2000 to 2015 preceded by approximately 34 pages of preface and introduction, commentary, summary, and bibliography sections.

The introduction familiarizes the reader with the principle of scintillator and scintillation detector including basic scintillator characterization. This part makes evident the author's excellent pedagogic capability

The commentary includes three parts devoted to the author´s results of investigation and development into the following scintillators: (1) Aluminium and multicomponent garnet scintillators, (2) Aluminium perovskite scintillators, and (3) Ortho and pyrosilicate scintillators. In each material family, the results presented provide an outlook for the emission properties of doped fast luminescence centres, namely Ce^{3+} and Pr^{3+} which enable obtaining the dominant part of scintillation response in the time scale of tens-hundreds nanoseconds. Considerable effort has been paid to the study of trapping charge carriers in the transfer stage of scintillator mechanism which in all the materials introduces delayed radiative recombination processes responsible for slower components in scintillation decay and afterglow.

Two modern strategies of the development of novel and/or optimized of the existing single crystal scintillators were used:

(1) The band gap engineering approach consisting in the essential change in electronic band structure of the original material, mostly by alloying it with another component providing a solid solution single crystal material. This strategy appeared extremely productive, e.g. in the group of garnet scintillators, where balanced admixture of Gd and Ga into the structure of classical $Y_3Al_5O_{12}$ or $Lu_3Al_5O_{12}$ aluminium garnets gave rise to new ultraefficient multicomponent garnet scintillators with light yield approaching 60 000 phot/MeV.

(2) The defect engineering strategy has been exploited in a number of cases throughout all the history of scintillators focusing on the optimization of particular

parameter(s) important in applications by the suppression or creation of specific defect(s). Doping and co-doping by a specific ion often accompanied by post-preparation annealing in a defined atmosphere are used for such a purpose. This approach was utilized successfully, e.g. in the scintillation mechanism of Ce-doped garnet single crystal scintillators by revealing the role of stable Ce^{4+} centre.

It must be stressed here that all the research described was realized in intense international cooperation headed by Ing. Nikl. The results of this study have been successfully utilized in optimization of the scintillator manufacturing technology.

All 23 papers included represent original research work published in well-known international peer-reviewed journals such as: Physical Review B (7 papers), Phys. Stat. Sol. (a) and (b) (4 papers), IEEE Trans. Nucl. Sci. (3 papers), Progr. Cryst. Growth Charact. Materials (1 paper), Crystal Growth, & Design (2 papers), J. Phys. D: Appl. Phys. (2 papers), Opt. Materials (1 paper), Nucl. Instr. Meth. Phys. Research (1 paper), J. Appl. Physics (1 paper), and J. Phys. Chemistry (1 paper). These papers reach 769 citations (from Web of Science on April 18, 2015). Furthermore two invited papers (510 citations) and a book chapter related to the thesis topic are added. The h-index of Ing. Nikl equals 47. These figures clearly show that his work is outstanding well visible, recognized, and appreciated in the international research community.

All these achievements prove conclusively that Ing. Nikl is a very talented and experienced physicist who has been continuing to explore new areas of research and development in the branch of Applied Physics. Moreover, he is sufficiently experienced and skilled to supervise PhD students.

In summary, I conclude that Ing. Martin Nikl, CSc. is perfectly qualified to be appointed as an Associated Professor and to defend his work during an oral presentation at the Faculty of Nuclear Sciences and Physical Engineering, Czech Technical University in Prague.

Prague April 18, 2015

(Zdeněk Bryknar)