Ionoluminescence analysis of irradiated oxides. Case study of powellite

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Scientists studying the effects of ion irradiation and implantation are well aware of the fact, that many materials glow when hit by ion beams. It is also clear, that the light emitted from a solid contain the information about the material structure, including changes induced by the incoming ions. The ion beam may serve thus a twofold purpose: induce material modification and in the same time send the information about the changes caused by irradiation. It is a perfect example of the *in-situ* measurement. In this work we studied Ar-irradiated $CaMoO_4$ (single crystalline powellite) by using three complementary techniques: Rutherford Backscattering/Channeling (RBS/C), cathodoluminescence (CL) and ionoluminescence (IL). The main aim of the study is to get a better insight into potential of the IL technique, especially for the damage accumulation analysis in polycrystalline solids, when the use of the RBS/C method is impossible.

The $CaMoO_4$ crystals were irradiated with increasing fluences of 320 keV Ar ions in order to create various levels of radiation damage. RBS/C measurements provided quantitative data about damage concentration in the samples, these values were compared to the luminescence measurements. All measurements point to a two-step damage accumulation mechanism involving the defect transformation at about 10^{15} cm^{-2}. The main difference between luminescence and RBS/C results is the fact that the main decrease of the luminescence signal is observed in the first stage of the damage accumulation (characterized by the formation of small defect clusters), whereas huge changes in the RBS/C spectra are observed in the second stage (when dislocations are preferentially formed). Both methods appear thus as complementary techniques. The huge advantage of the luminescence measurements relies in the fact that such an analysis may be performed also for polycrystalline samples and allows one to extract the threshold irradiation fluence for defect transformation and cross-sections for defect formation at each step of the damage accumulation process in polycrystalline solids.