Workshop on Active Targets and Time Projection Chambers for High-intensity and Heavy-ion beams in Nuclear Physics

ID de Contribution: **13** Type: **Non spécifié**

Sputtering and heating of targets and foils in high-intensity heavy-ion beam experiments

mercredi 17 janvier 2018 18:05 (20 minutes)

Sputtering of targets and target backing foils irradiated by intense heavy ion (HI) beams in long-term experiments has been considered on the grounds of available models and experimental data. Experiments on synthesis of superheavy nuclei (SHN), which are carried out in Dubna with Gas-Filled Recoil Separator (DGFRS), are the examples of such kind of experiments. High fluxes of HIs and heat generation, which are realized within a relatively small area and thickness of these elements of DGFRS, are inherent in such experiments. At present, the 48Ca beam with the intensity of about 1 pμA allows obtaining several atoms of SHN per month at their production cross section of several pb and the efficiency provided by DGFRS. The detailed study of properties of SHN produced in the experiments with complete fusion reactions induced by the 48Ca projectile on actinide target nuclei, which lead to nuclei with 112≤Z≤118, implies the use of HI beams with intensities significantly higher than those used in the discovery experiments [1]. Moreover, synthesis of SHN with Z>118 implies the use of the heavier than 48Ca beam particles (50Ti, 54Cr etc.). One may expect the production cross section values less than 0.05 pb for SHN formed in the fusion-evaporation reactions with these projectiles. It means that for the observation of two decay events of SHN produced with the cross section of 0.05 pb one should collect the beam dose of 10^20 particles, using the target of 0.4 mg/cm2 in thickness and having total detection efficiency of 40%. This dose of particles passed through a stationary target may cause total disappearance of radioactive target material at the end of the experiment if the sputtering yield of the material is estimated as 0.01 atom/ion. In the case of the rotating target one can essentially reduce the yield of sputtered atoms due to the gain in the irradiation area.

Heating the target and target backing foil as a single whole caused by an intense HI beam can be estimated with the use of some approximations. The temperature of the target and target backing is calculated as a function of time in the conditions of pulse heating followed by subsequent cooling with radiation emitted from their surfaces. Such pulsing mode corresponds to the rotating target irradiated by a continuous HI beam in the experiments. Estimates show that radiative cooling in the conditions of pulse heating can be the most effective way of heat transfer to the surroundings at the temperature of several hundred degrees. Such temperatures can be reached on the surfaces of the target and foils irradiated by HI beams at the intensities exceeding 10^13 particle/s [2].

[1]. Yu.Ts. Oganessian, V.K. Utyonkov, Nucl. Phys. A 944 (2015) 62.

[2]. R.N. Sagaidak, Physics of Particles and Nuclei Letters 14 (2017) 747, Pleiades Publishing, Ltd., 2017.

Author: Dr SAGAIDAK, Roman (Flerov Laboratory of Nuclear Reactions, Joint Institute for Nuclear Research)

Orateur: Dr SAGAIDAK, Roman (Flerov Laboratory of Nuclear Reactions, Joint Institute for Nuclear Research)