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Ca-48 HANDLING FOR A CYCLOTRON ECR ION SOURCE TO PRODUCE HIGHLY INTENSE ION BEAMS

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Production of highly intense ion beams of ^{48}Ca is one of the main tasks in experiments carried out within the framework of the synthesis of new superheavy elements. ^{48}Ca is very rare and expensive isotope, therefore there is necessity to reach the high intensity of ion beams of the isotope at a low consumption rate.

Analysis and our preliminary experiments have showed, that the best way of producing highly intense calcium ion beams is evaporation of metallic calcium in an ECR ion source. So we have developed a technique of metallic ^{48}Ca production by reducing CaO (this chemical form is available at the market with 40-80% of ^{48}Ca) with aluminium powder. We used two tantalum crucibles: the big one with a mixture of CaO + Al heated at up1250^{o}C was connected with the small one(2 mm I.D. and 30 mm long) in which calcium vapour condensed. The temperature distribution in the small crucible was ~50^{o}C at the bottom and ~500^{o}C in the middle of the crucible. The pressure inside of the set-up was ~0.1-1 Pa. The production rate of metallic ^{48}Ca was 10-20 mgh^{-1}. The crucible with the condensed metallic Ca in argon atmosphere was transferred to the ECR-4M ion source, where it was inserted in a wired tubular oven and the calcium evaporation was regulated by the applied power supply of the oven. The application of metallic ^{48}Ca as working substance for the ECR-4M ion source of the U-400 cyclotron of JINR FLNR allowed us to approach the stable high intensity of ^{48}Ca ion beams, namely, the intensities for the internal and external beams were 10^{13} c^{-1} and 3×10^{12} c^{-1} respectively, at a consumption rate of ~ 0.4 mgh^{-1}. A technique of isolation of ^{48}Ca from the residue inside of the big crucible and from the inner parts of the ECR ion source was developed. Extracting Ca from the inner parts of the ion source enabled us to save up to ~25% of the calcium used in the ECR ion source, so that the real consumption rate was ~ 0.3 mgh^{-1} at the highest intensities of ^{48}Ca ion beams in the U-400 cyclotron.

To control the ^{48}Ca movement during the preparation of metallic calcium, recuperation of the calcium and to obtain a picture of the distribution of the ^{48}Ca deposits inside the ECR ion source, we used ^{47}Ca as a radiotracer. ^{47}Ca was obtained in a ^{48}Ca(γ,n)^{47}Ca reaction when a mixture of ^{48}CaO + Al, prepared for the reduction of the calcium, was irradiated with the bremsstrahlung (E_e = 22 MeV) of the microtron MT-25 of JINR FLNR. The radiotracer technique provided us with ^{48}Ca control in all processes of calcium of the ECR ion source after stopping and calcium separation from acidic solutions, that allowed us to minimize our losses of ^{48}Ca.

The whole technique was very effective in dealing with such expensive isotope as ^{48}Ca. During the last years at FLNR JINR (Dubna) several isotopes of element 114 and 116 have been obtained by irradiation of Pu and Cm targets with highly intense ^{48}Ca ion beams .