On the synthesis of neutron-rich isotopes along the N = 126 shell in multinucleon transfer reactions*

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We studied multinucleon transfer processes in near barrier collisions of heavy nuclei with a goal to investigate possible population of isotopes along the N=126 shell. In particular we investigated deep inelastic transfer (DIT) reactions in the heavy collision system ^{64}Ni+^{207}Pb at 5.0 MeV/u using the velocity filter SHIP and its detection system (see [1]).The isotopic identification was performed via γ-decay spectroscopy in the focal plane of SHIP. All identified isotopes which were directly populated in the reaction are displayed in the chart in fig. 1. As one can see, nuclei were populated in both, neutron-deficient and neutron-rich regions relative to the stability line. From the intensities of the measured γ lines we deduced total production cross-sections for the respective isotopes. As an example the obtained total cross-sections of osmium(Z=76) and platinum(Z=78) isotopes as a function of the nucleon number A are shown in fig. 2 a,b as full circles.

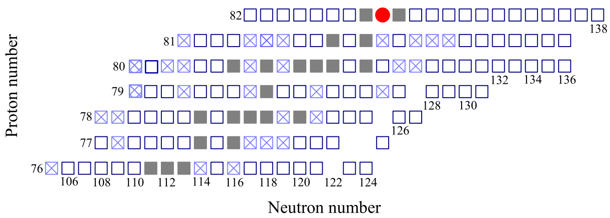

Figure 1: Part of the nuclide chart with the identified isotopes (crosses)

Very similar reactions were studied by another group in ^{64}Ni+^{208}Pb collisions at the beam energy of 350 MeV [2]. The data from [2] for isotopes with osmium and platinum are shown as open circles in fig. 2 a,b. Our measured cross-sections and the ones in [2] differ in most cases within one order of magnitude. In both experiments no new isotopes were discovered or identified, respectively, and as well the N = 126 shell was not reached for nuclei with Z<80.

It is interesting to compare the isotopic distributions and cross-sections reached in DIT reactions with those from fragmentation reactions which is presently the applied technique to produce neutron-rich isotopes in the region below Uranium. The most neutron-rich isotopes for the elements discussed here were so far reached in fragmentation reactions [3, 4].The obtained cross-sections are represented by the asterisks in fig. 2 a,b. The fragmentation and DIT cross-sections are mostly within the same oder of magnitude for the isotopes discussed here and towards the neutron-rich side the DIT cross-sections even tend to exceed the fragmentation cross-sections.

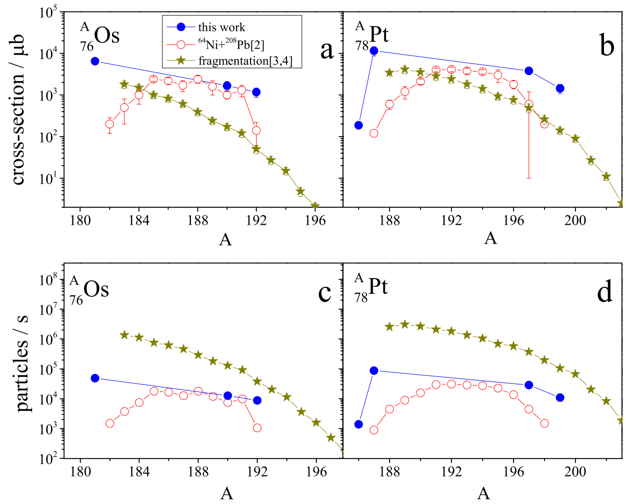

Figure 2: Total production cross-sections (a,b) and count rates (c,d) of DIT and fragmentation reaction products

In the next step we compared the production yields for the observed isotopes which can be expected in DIT and fragmentation reactions (see fig.2 c,d). As one can see, the estimated yields (at the target) for the same isotopes are typically about one or more orders of magnitude higher in fragmentation reactions. This is due to the more favorable experimental conditions in fragmentation reactions concerning the product of beam intensity and target thickness. Therefore, in order to become more profitable than fragmentation reactions, the yields of DIT products have to be increased considerably.

References

[1] O. Beliuskina, et al., Eur. Phys. J. A **50**, 161 (2014)

[2] W. Krolas, at al, Nucl. Phys. A **724**, 289 (2003)

[3] E. Casarejos, et al, Phys. Rev. C**74**, 044612 (2006)

[4] Teresa Kurtukian-Nieto, PhD thesis work, University of Santiage de Compostela, Spain, Januar 2007

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