Production of neutron-deficient astatine and radon isotopes in complete-fusion reactions

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The complete fusion reactions represent one of a few possibilities to produce short-lived neutron-deficient isotopes. The precision of the theoretical production cross sections is especially critical for the search of new isotopes. The confrontation of the experimental results with theoretical predictions therefore provides a valuable information about the accuracy and reliability of the calculations.

The excitation functions of complete fusion reactions leading to neutron-deficient astatine (^{197}At*) and radon (^{199,201,202}Rn*) compound nuclei were evaluated from the experimental data measured at the SHIP separator (GSI, Darmstadt). The combination of the new cross-section data with the known values from the literature allows to investigate the production systematics of the complete fusion reactions in this region.

The theoretical excitation functions for each reaction were calculated by the statistical code Hivap [1]. Hivap is a simple tool used to evaluate theoretical cross sections. The calculations reach a sufficient accuracy combined with a relative simplicity. One of the important input parameters is the fission barrier height according to the rotating liquid drop model [2]. The cross section studies of bismuth and polonium isotopes ($Z = 83, 84$) showed a linear dependence between fission barrier reduction and mass number of the compound nuclei [3]. The significant reduction of the fission barrier as large as 37% was required to satisfactorily reproduce the experimental excitation functions for ^{187}Bi*.

The search for new very neutron-deficient isotopes near the $Z = 82$ closed shell may be hampered by the quasi-fission, hindering the creation of compound nuclei. The reactions leading to these isotopes are placed well withing the quasi-fission occurrence, experimentally deduced in ref. [4]. The ongoing series of experiments aimed on the symmetric reactions leading to ^{192,193}At* may therefore shed a light on the production of new isotopes in this region.

[1] W. Reisdorf, Z. Phys. A **300** (1981) 227–238.
[2] S. Cohen *et al.*, Ann. Phys. **82** (1974) 557–596.
[3] A. N. Andreyev *et al.*, Phys. Rev. C **72** (2005) 014612.
[4] R. du Rietz *et al.*, Phys. Rev. C **88** (2013) 054618.