Abstract

The region of neutron-deficient isotopes near the closed proton shell provides an opportunity to study nuclear structure phenomena such as shape coexistence or nuclear isomerism. However, the production of isotopes far from the line of beta stability is challenging and requires reliable predictions of the expected yields of the reactions. This Dissertation Thesis focuses on two topics — the production of isotopes in fusion-evaporation reactions leading to astatine ($Z = 85$) and radon ($Z = 86$) compound nuclei and the α-γ decay spectroscopy of the neutron-deficient isotope ^{186}Bi ($Z = 83$). In the first part of the Thesis, cross section data from the reactions ^{52}Cr+^{147,149,150}Sm leading to ^{199,201,202}Rn* compound nuclei measured at the velocity filter SHIP in GSI Darmstadt, Germany, were evaluated. Complementary data from the literature for other reactions leading to radon and astatine compound nuclei were evaluated as well. By comparing experimental data to the theoretical calculations by the statistical model code HIVAP, the systematics of the reduction of the rotating liquid-drop model fission barrier heights was derived. The linear dependence of the fission-barrier scaling with respect to the mass number of the compound nucleus, known previously for bismuth and polonium compound nuclei, was confirmed in this work also for astatine and radon isotopes. A reduction for the lightest compound nuclei ^{193}At* and ^{196}Rn* of more than 50% was required to achieve agreement between theoretical and experimental excitation functions. A significant deviation from the linear trend of other astatine compound nuclei was observed for the reaction leading to ^{193}At*, in which ^{190}At was synthesized. In the second part of the Thesis, the excited states of ^{182}Tl populated by the α decay of ^{186}Bi were studied by the means of α- and γ-decay spectroscopy. The isotope ^{186}Bi is the α-decay daughter product of ^{190}At, the lightest currently known astatine isotope, recently studied during the measurement at the separator AGFA in Argonne National Laboratory, USA. New information about ^{186}Bi is therefore important for understanding the α decay and structure of ^{190}At. The isotope ^{186}Bi was produced in the ^{95}Mo(^{93}Nb, $2n$) and ^{46}Ti(^{144}Sm, $p3n$) reactions at SHIP. An extended decay scheme with several new transitions and levels was deduced. An alternative approach considering energy summing of conversion electrons and α particles was used and verified by the Monte-Carlo GEANT4 simulations. The discrepancies between recent laser-spectroscopy studies were outlined and discussed.

Key words: alpha decay, gamma-ray transition, decay spectroscopy, fusion-evaporation reactions, reaction cross section