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Synthesis of Hassium isotopes in reactions leading to the compound nucleus ^{274}Hs*

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Studies of complete fusion reactions leading to the superheavy compound nucleus ^{274}Hs allow a deeper understanding of the underlying nuclear reaction mechanism. Production cross sections for the reaction ^{26}Mg+^{248}Cm have been measured at five different energies. Thereby five new superheavy nuclides were observed for the first time using a highly efficient Hs chemistry system. First results concerning the reaction ^{36}S+^{238}U will be presented at the conference.*

Transactinides, Hassium isotopes, complete fusion reactions

I. INTRODUCTION

Studies of complete fusion reactions leading to production of superheavy elements (SHE) with $Z \geq 108$ are extremely difficult due to very low production cross sections. Excitation function measurements of evaporation residues from a fusion reaction together with measurements of the fusion – fission cross section provide important experimental information for understanding the process of compound nucleus (CN) formation and its survival in the competition between fission and neutron evaporation. The heaviest known nuclides at the limits of stability only exist due to strong shell effects. In macroscopic–microscopic calculations increased stability was predicted at and near N=162 and Z=108. This new area of increased stability corresponds to gaps in the single–particle spectra which appear only at deformed shapes. By using a larger deformation space and a dynamic treatment of the fission barriers, Patyk et al. [1] analyzed the single–particle spectra of heavy nuclei and predicted ^{270}Hs to be a relatively strongly bound "doubly–magic" deformed nucleus. The liquid-drop shell correction energies are predicted to be almost as strong as for spherical superheavy elements. Therefore, the region at and near N=162 and Z=108 can be regarded as an ideal work place to understand the synthesis of superheavy elements. Indeed, the compound nucleus ^{274}Hs* can be produced in several combinations of projectile and target with varying excitation energy. The reactions are ^{26}Mg+^{248}Cm, ^{30}Si+^{244}Pu, ^{36}S+^{238}U, and ^{48}Ca+^{226}Ra. Although the cross sections for the formation of evaporation residues are expected to reach only a few picobarns, our highly efficient chemical separation system COMPACT can be applied to isolate reaction products of the 3n, 4n, and 5n exit channel.

A. The reaction ^{248}Cm(^{26}Mg, 3-5n)$^{269\text{-}271}$Hs

In the framework of our project we investigated the nuclear reaction ^{248}Cm(^{26}Mg, 3-5n)$^{269\text{-}271}$Hs at five different beam energies covering an excitation energy range of 35-53 MeV of the compound nucleus. The measured cross sections were of the order of few picobarns, see Fig. 1. We were able to determine the decay properties of the new nuclide ^{270}Hs [2] and observed decay signatures indicating the observation of the new nuclide ^{271}Hs [3].

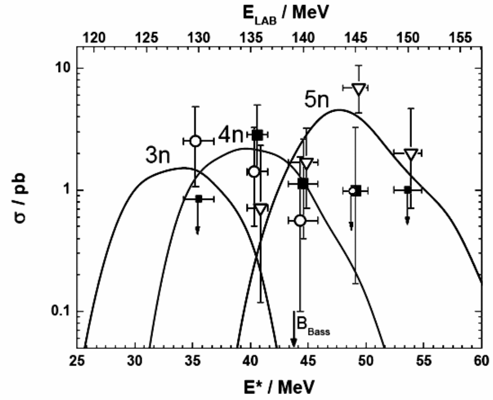

Figure 1: Comparison of production cross sections measured for the reaction ^{248}Cm(^{26}Mg,5-3n)$^{269-271}$Hs (symbols) along with excitation functions calculated with HIVAP (lines) [4].Error bars represent 68% confidence intervals.

B. The reaction ^{238}U(^{36}S, 3-5n)$^{269\text{-}271}$Hs

First results concerning excitation function measurements of the reaction ^{36}S + ^{238}U leading to element 108, hassium will be discussed at the conference.

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