Low-energy proton spectra from proton-induced reactions at 392 MeV

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In the intermediate energy range, the combined model [**?**] of quantum molecular dynamics (QMD) + statistical decay model (SDM) is one of powerful tools to estimate particle production double differential cross sections (DDXs) and has been used widely for engineering, medicines and other applications. However, it is pointed out [**?**] that the predictive ability of QMD+SDM calculation has not been examined on DDX in the evaporation energy region. Since low-energy protons play a key role in hydrogen brittleness in material, the reliable estimation is important. The aim of this work is to measure the low-energy part of proton spectra and compare it with QMD+SDM calculation.

The measurement was carried out at the ring-cyclotron facility of the Research Center for Nuclear Physics, Osaka University. The proton beam of 392 MeV bombarded four targets, C, Al, Nb, and Pb in a large scattering chamber of 800-mm diameter. Emitted particles were detected by using three telescopes made of double delta-E and E counters located inside the chamber. The delta-E counters were silicon surface barrier detectors, and the E counter the GSO crystal coupled to a photomultiplier tube. The measured angles were 20, 40, 60, 75 and 105 deg. A typical energy spectrum is shown in Fig.1 for a target of ^{12}C, measured at 75 deg. The evaporation is remarkable below 10 MeV. This trend is consistent with previous experimental data [**?**] of bombarding energies, 65 and 75 MeV.

Figure 1: Double differential cross section (DDX) for inclusive ^{12}C(p,p$'x$) reaction at 392 MeV. Comparison is made with QMD and QMD+SDM calculations.

In Figure **??**, measured data are compared with calculated results given by lines. The dotted line displays energy spectra of protons due to sole the fast process by QMD. The solid line is the sum of the fast and the evaporation contributions, QMD+SDM. According to comparison at the higher energies $>$ 20 MeV, the disagreement is about 10 %. In the lower energy regime, the deviation is larger. It seems that suppression of particle emission due to Coulomb barrier are not explained in the calculation very effectively, or the fast process contributes too much. Detailed analyses are in progress.

The experiment was performed under program number E246.

References

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