Target Performance – $[^{11}C]CO_2$ and $[^{11}C]CH_4$ Production

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Introduction

A systematic investigation on N_2 (0.1 % O_2) and N_2 (5 % H_2) target performances is presented in terms of saturation yields as function of target body temperature and irradiation current.

Materials and methods

Identical aluminium target bodies were used for both $[^{11}C]CO_2$ and $[^{11}C]CH_4$ productions. The conical chambers measured 11.2 x 90.0 x 19.4 mm (front I.D. x length x back I.D.) and 16.9 cm^3. The inlet foil was supported by a metallic grid having a transparency of ~ 70 %. In all irradiations the chambers were loaded at 20 °C to 35 bar pressure and irradiated for 20 minutes. Variable parameters were the target body temperature (10, 40, 70 °C), regulated with a cooling fluid circuit and a heat exchanger, and the irradiation current (10, 20, 30, 40 µA). For the data points n = 2. The proton beam was generated with a fixed energy (17 MeV) negative ion cyclotron (CC 18/9, D.V. Efremov Scientific Research Institute of Electrophysical Apparatus, St. Petersburg, Russia).

The irradiation product was directed to a hot cell via a capillary and valve arrangement and a mass flow controller. The main ^{11}C-species was first separated from the target gas using a selective trap: Porapak N column in Ar(Liq) for the $[^{11}C]CH_4$ and an Ascarite column at room temperature for the $[^{11}C]CO_2$. The traps were placed in a dose calibrator and the irradiated gas that passed a trap was collected as gas. The collected volume was readable from the gas trap and an aliquot could be taken for radioactivity measurement.

The ^{11}C main product yield was thus measured on-line with the dose calibrator containing the first trap. The content of ^{11}C and ^{13}N in the second trap was determined by iterating the decay curve fitting to the radioactivity values at early and late time points. Yields for the ^{11}C main product and ^{11}C and ^{13}N by-products were calculated as saturation activities (A_{sat} [GBq/microA]).

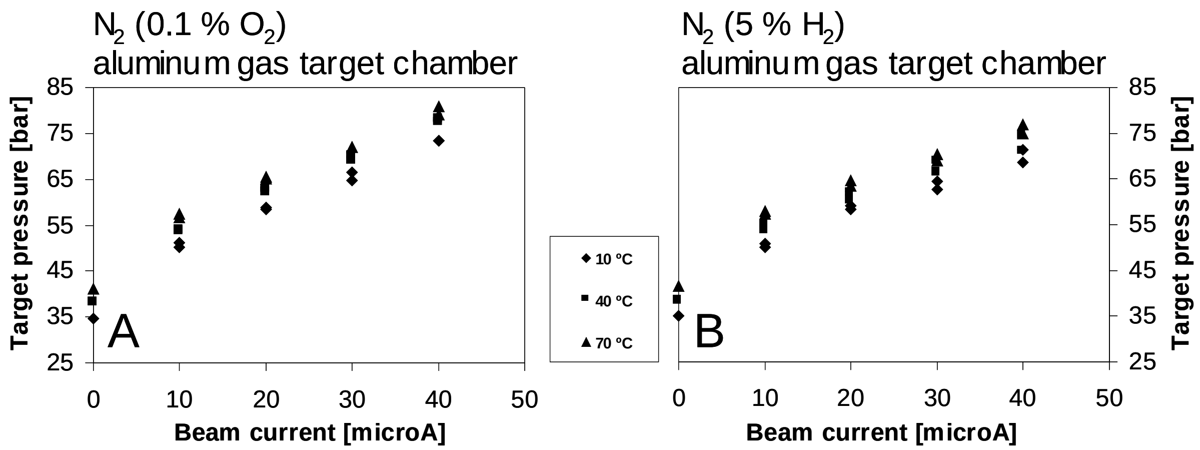

Figure 1. Pressure versus irradiation current at different target body temperatures

Results

The pressure increase as function of beam current was similar for both targets (figure 1). A slight difference was observed at higher currents.

The main component yield is practically constant for the [^{11}C]CO_2 (figure 2, pane A) across the range of varied target body temperature and irradiation current. The [^{11}C]CH_4 yield (figure 2, pane B) is directly proportional to the temperature and inversely proportional to the current.

[^{11}C]CO generation in the N_2 (0.1 % O_2) target is low and inversely proportional to temperature and constant across the investigated current range. [^{11}C]by-product generation is negligible in the N_2 (5 % H_2) target.

^{13}N generation is constant across the range of current and temperature using either N_2 (0.1 % O_2) or N_2 (5 % H_2) target gases. However, ^{13}N production is slightly lower for the N_2 (5 % H_2) target.

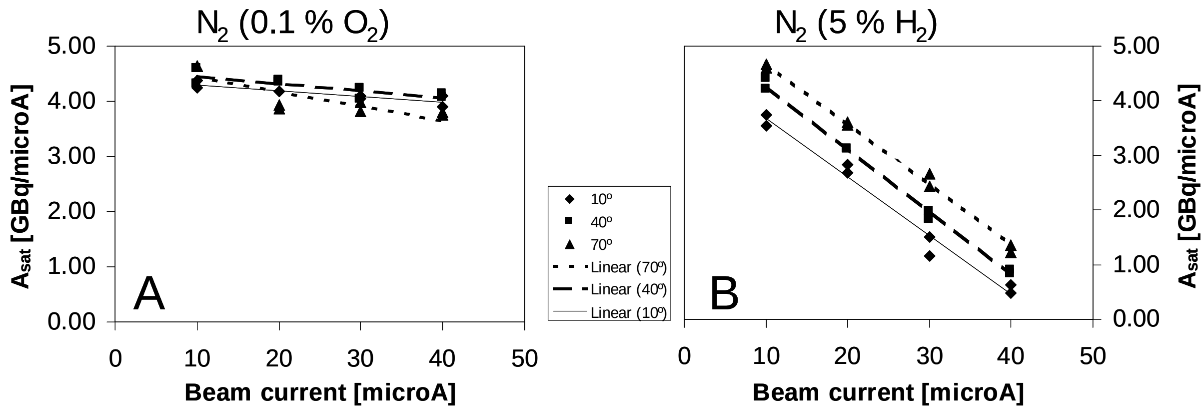

Figure 2. Yield of the main component as a function of irradiation current at 10 – 70 °C.

Conclusions

Production of [^{11}C]CO_2 is practically independent of the irradiation current and the target body temperature, whereas [^{11}C]CH_4 production was found to be strongly dependent on the current and target body temperature.

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