Basic Compound Synthesis for ^{14}C Quality Verification Utilizing HANARO

Hyun Sung Lee, Su Seung Lee and Ul-Jae Park*

Division of Radioisotope Research, Department of HANARO Utilization
Korea Atomic Energy Research Institute (KAERI),
111, Daedeok-daero 989beon-gil, Yuseong-gu, Daejeon, 34057 Republic of Korea

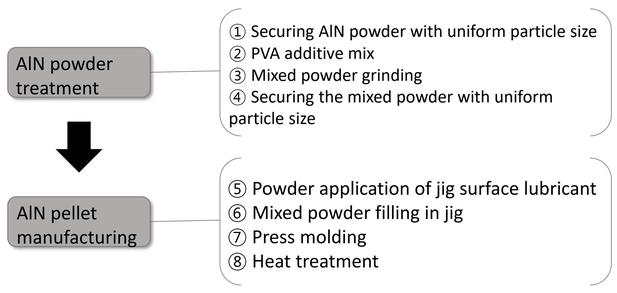
Corresponding author: ujpark@kaeri.re.kr

01 Introduction

- ^{14}C is a pure beta-emitting radioactive isotope that is the most commonly used in the form of a labeled compound with ^{3}H. In addition, ^{14}C is an isotope of carbon, a basic element of organic compounds, and be used as a radiotracer for physiological activity, metabolic tracing, and environmental change tracing in fields such as drug delivery systems, clinical research, and the environmental fields.
- A significant amount of ^{14}C labeled compounds are being used in Korea, the production of labeled compounds is restricted because most of the basic raw material, ^{14}C, are imported and used from the abroad. To overcome this problem, it is preparing to produce ^{14}C using HANARO and will synthesize various basic compounds using ^{14}C are produced.
- In this study, Aluminum Nitride (AlN) not irradiated with neutrons recovers as $BaCO_3$ in carbonate form, and various basic compound synthesis experiments run using $BaCO_3$.

02 Outline

- $^{14}N_7 + ^{1}n_0 \rightarrow ^{14}C_6 + ^{1}p_1$, σ=1.81b, t(1/2) = 5370 years <^{14}N(n,p) nuclear reaction>
- AlN pellet manufacturing method



- Mixed powder was made of AlN powder 5 g + PVA 0.75 ml
- Pellets were made using 4 g of the mixed powder, and pellets with a diameter of 16 mm X height of 8.9 mm were made using a press
- Heat treatment at 1000°C for 3 hours

CO_2 generation process

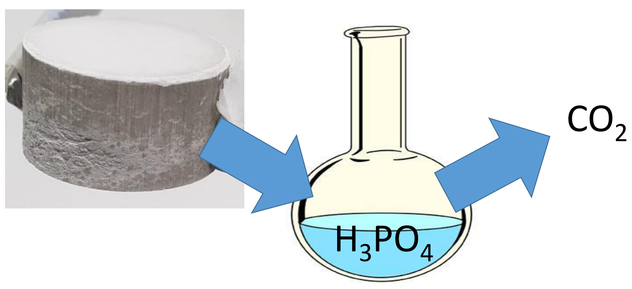
$AlN + H_3PO_4 \rightarrow CO_2$

CO_2 solidifying process

$CO_2 \rightarrow BaCO_3$

$$BaCO_3 + H_2SO_4 \xrightarrow[Et_2O]{MeMgI} CH_3COO^-Na^+$$

03 CO_2 generate and solidifying



Reagents	Volume
H_3PO_4	200 ml
$K_2Cr_3O_7$	50 ml
0.1M NaOH	100 ml (x2)
0.1M $Ba(OH)_2$	100 ml (x2)

- Dissolving AlN pellet target in H_3PO_4 generates CO_2.
- The produced CO_2 was collected using 0.1M NaOH, and then CO_2 was solidified using $Ba(OH)_2$.
- After the solidified CO_2 is filtered, the weight is measured after drying.

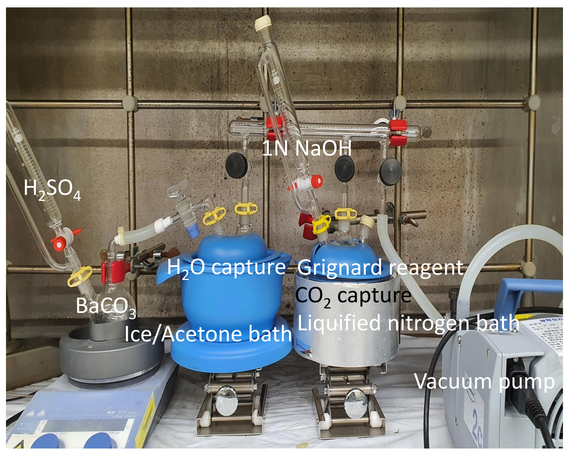
04 Sodium acetate synthesis

- Sodium acetate synthesis using reagents

Reagents	Volume (g, ml)
$BaCO_3$ (s)	1 g
H_2SO_4 (l)	9 ml
MeMgI in ether (l)	3.2 ml
1N NaOH (l)	16.2 ml
Ag_2SO_4 (s)	1.9 g
20% H_2SO_4 (l)	8.8 ml

- CO_2 was generated from $BaCO_3$ to synthesize sodium acetate.
- Optimization work was done through several synthetic experiments.

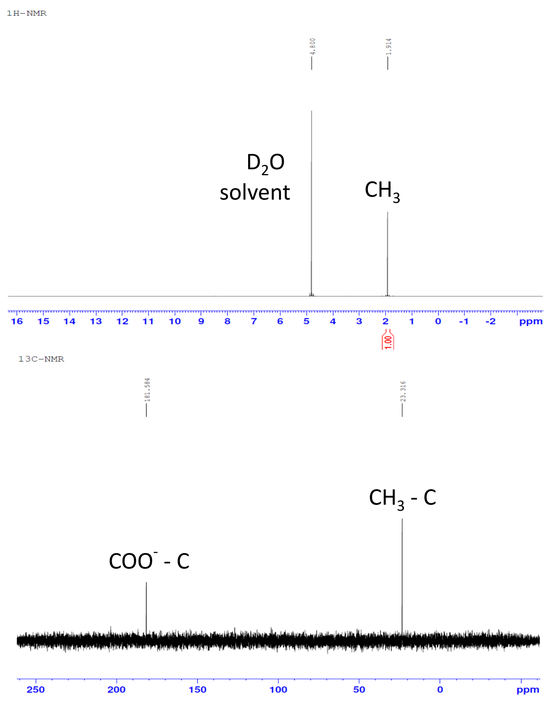
- Sodium acetate synthesis methods



- In order to increase the yield and purity in the synthesis process, the tightness of the experimental equipment was focused.

05 Results

- The amount of $BaCO_3$ produced from one AlN pellet target irradiated at HANARO was calculated 2.14 mg. And also, the amount of CO_2 gas generated from $BaCO_3$ was only 2.43 ml in STP.
- As a result of increasing the vacuum level by changing the gas leak and the experimental equipment, the yield of basic compounds was increased from 50% to 86%.



- Through the NMR analysis confirms that the synthesis of the desirous basic compound.
- NMR spectrum sustains that the desired basic compound neatly synthesizes without impurities.

06 Conclusion

- In this study, C was recovered in the form of $BaCO_3$, and the sodium acetate synthesis process was optimized to increase the yield and reduce waste, and the desired results were obtained.
- The optimal conditions will be applied to the synthesis of basic compounds using ^{14}C which will be produced through HANARO in the future.