Separation of Trace Level Sm and Nd: A Prerequisite for the Measurement of ^{146}Sm by AMS

S. Maji [a], G. Korschinek, S. Lahiri [b], and B. Wierczinski [c]
[a] Department of Chemistry, The University of Burdwan, Burdwan 713104, India
[b] Chemical Sciences Division, Saha Institute of Nuclear Physics, 1/AF Bidhannagar, Kolkata 700064, India
[c] Institut für Radiochemie, Technische Universität München, Walther-Meissner-Strasse 3, 85748 Garching

Some radionuclides like ^{146}Sm($T_{1/2}$=10^8 y) are believed to be of supernova origin. The detection of these radionuclides may be useful for understanding the formation of our solar system. However, calculations show that the maximum abundance of these radionuclides is extremely low. Thus the abundance ratio of their radionuclides to these stable counterparts is below 10^{-16}. Accelerator Mass Spectrometry (AMS) might be able to detect these radionuclides in such a low concentration. As a prerequisite to detect ^{146}Sm by AMS, it must be free from any naturally occurring stable isobar. ^{146}Nd is naturally abundant, thus the sample we might look for ^{146}Sm should be "free" from ^{146}Nd. As a first step we studied the Sm–Nd separation by chemistry.

Sm and Nd, because of their similar chemical properties, always occur together in nature. The phenomenon of lanthanide contraction is mainly responsible for the congenericity, causing extemely difficulties of their mutual decontamination. There are no suitable methods available for this separation so far.

To simulate the separation we have irradiated ^{nat}Sm and ^{nat}Nd by TU Munich research reactor (FRM II) to get ^{153}Sm and ^{147}Nd as precursors of Sm and Nd. In LLX studies, the extractant solutions of the desired concentrations were prepared by adding calculated amounts of bis(2-ethylhexyl)phosphoric acid (HDEHP) with cyclohexane as solvent. In each case of the extraction, 10 ml of HCl have been mixed thoroughly with an equal volume of HDEHP solution of the desired concentration. The mixture has been shaken vigorously for about 10 min. After extraction, the radioactivities present in both aqueous and organic phases were measured by a HPGe detector and characterized by γ-ray spectroscopy. The distribution coefficients as well as the percent extraction of the elements by the reagent under HCl and HCl mixed with the reducing agent hydroxyl amine were calculated.

At 0.025M HCl with 0.1% HDEHP 100% of Sm was extracted into the organic phase along with only 6% of Nd. This has been stripped back again in 0.1M HCl. Then multiple extractions were carried out, for reducing the contamination of Nd from Sm. By this way the Nd contamination could be reduced 1000 times from the original samples.

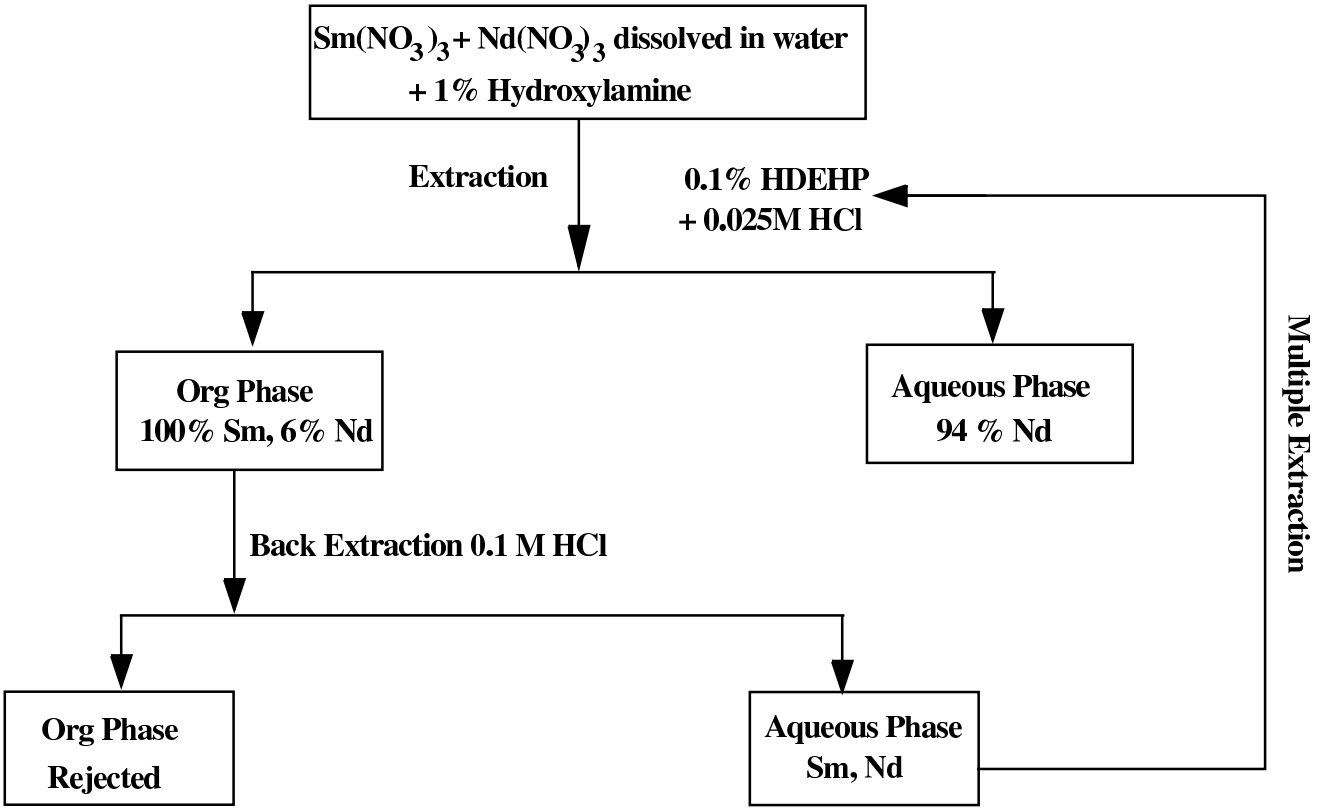

Fig. 1: Schematic diagram of the separation of Sm and Nd