

Research and development of high-sensitive measurement of trace amount of radioactive elements in organic materials for KamLAND2-Zen

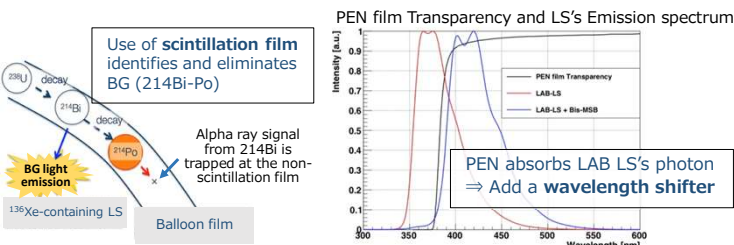


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1. KamLAND2-Zen

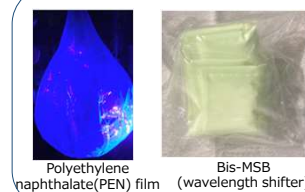
- Future plan with improved KamLAND2-Zen for $0\nu 2\beta\beta$ search
- Target sensitivity: $\langle m_{\beta\beta} \rangle \sim 20\text{meV} / 5\text{year}$
- A new scintillation film (PEN), wavelength shifter (Bis-MSB) to be installed



2. Motivation

- To Measure RIs*(U/Th) in new materials for KamLAND2-Zen and select components

- KamLAND2-Zen's requirements
PEN: $O(1)$ ppt** for U/Th
Bis: 30 ppt for U, 100 ppt for Th



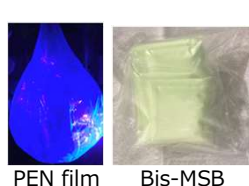
- Sensitivity is limited to a few ppt level in ordinary RI measurement such as U and Th by ICP-MS

Measurement by outsourcing (PEN)	
^{238}U [ppt]	^{232}Th [ppt]
36	< 5 ← Upper limit only

* RIs: Radioactive Impurities
** ppt: 10^{-12} g/g

- Establish highly sensitive (< 1 ppt) measurement method for U/Th in organic materials

3. Methods of Measuring Radioactive Elements



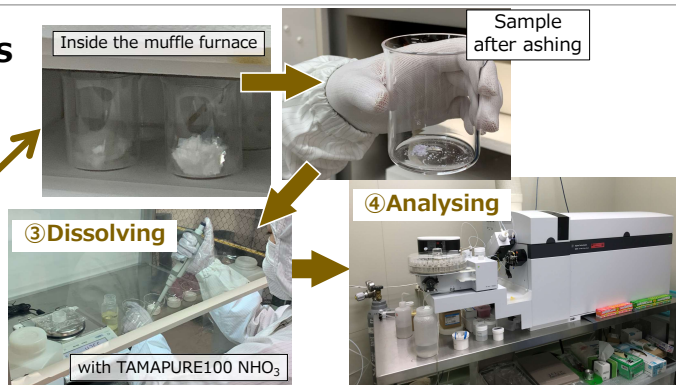
Other organics used in KamLAND2-Zen



Ultrasonic cleaning



Ashing equipment

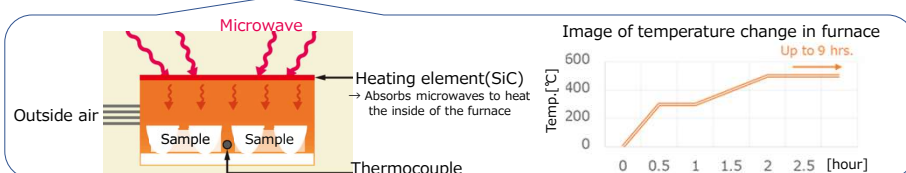


ICP-MS (Agilent 8800)

- Elemental analysis of Aqueous solution sample
- ppt level sensitivity

- High sensitivity measurement by making U/Th concentration high by methods ② and ③

- Working in clean rooms at Tohoku Univ. and Univ. of Tsukuba

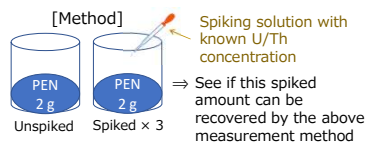


4. Current measurements

PEN

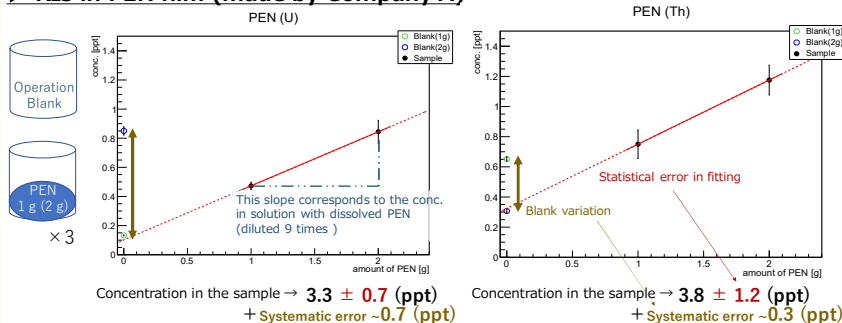
Spiked recovery test (PEN)

- Check if U/Th is recovered in the ashing/dissolving process (Check for U/Th missing from the sample due to evaporation, dissolution residue, etc.)



	U	Th
Actual spiked amount (ppt)	2.85 ± 0.06	2.50 ± 0.13
Measured amount (ppt)	2.96 ± 0.05	2.35 ± 0.07
Recovery factor (%)	103.7 ± 2.8	94.1 ± 5.6

RIs in PEN film (made by Company A)



- Meets KamLAND2-Zen's requirement
- Systematic error is large \Rightarrow Need to reduce uncertainty due to blank

RIs in PEN film (made by Company B)

- If we use PEN film in KamLAND2-Zen, Co. B's PEN is one candidate (due to the Co. A's getting out of PEN business)
- The dissolving was different from Co. A's one \Rightarrow Concentration not measured now, dissolving method will be investigated



Bis-MSB

RIs in Bis-MSB

	U		Th	
	Conc. (ppt)	σ	Conc. (ppt)	σ
Sample_1	124.8	1.4	139.3	1.9
Sample_2	116.2	1.0	165.5	1.2
Sample_3	128.4	1.0	111.3	1.1
	123.1	6.3	138.7	27.1

\sim One order more than required \Rightarrow Purification is necessary

5. Prospects

- Improving clean environment to reduce operation blank
- Increasing the sensitivity by chemical separation
- Applying water extraction method to reduce Bis-MSB RI