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Potentiometric Sensors for Rare Earth Metals based on Commercial Calcium Ionophores

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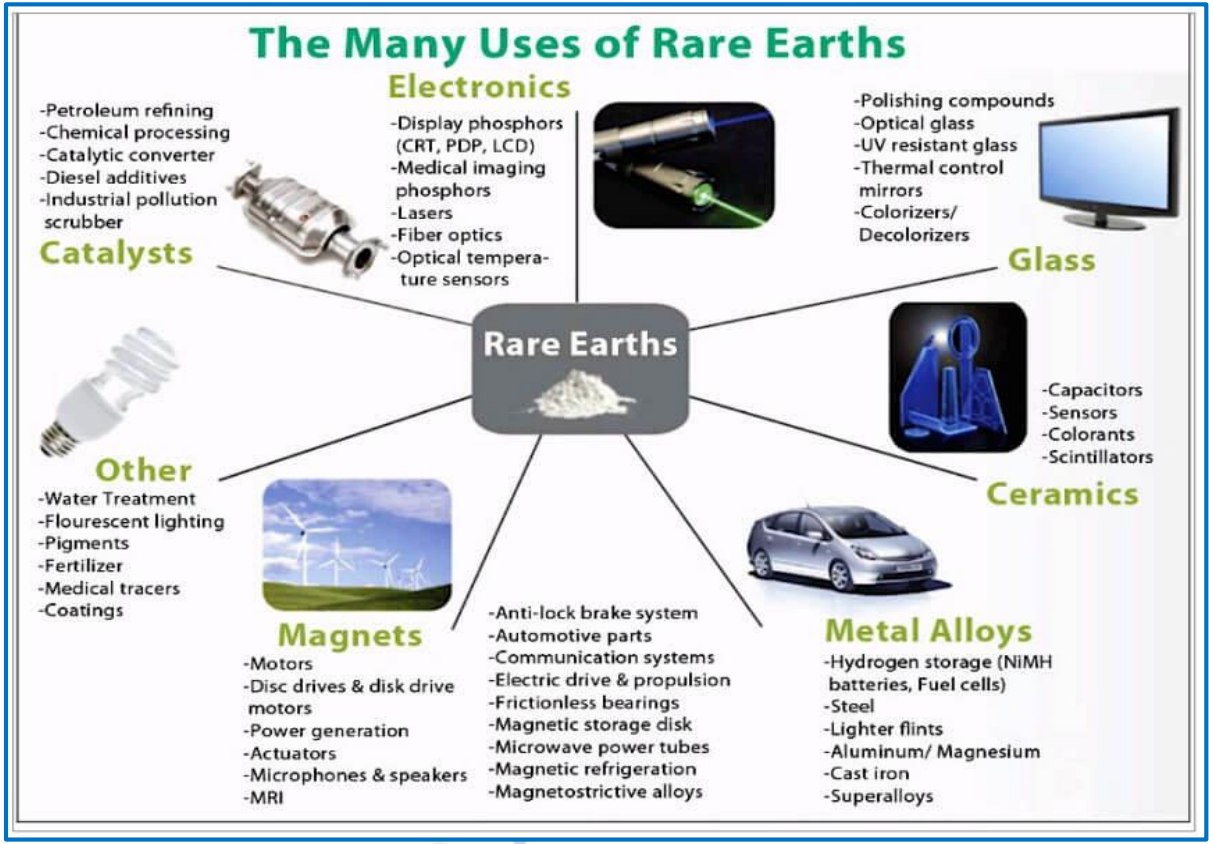
Problem Statement

REMs applications

- ❑ Household appliances
- ❑ Alloys making
- ❑ Electronic devices
- ❑ Superconductors
- ❑ Ceramics
- ❑ Catalysts
- ❑ Fertilizers
- ❑ Glasses
- ❑ Magnets
- ❑ Other



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Problem Statement

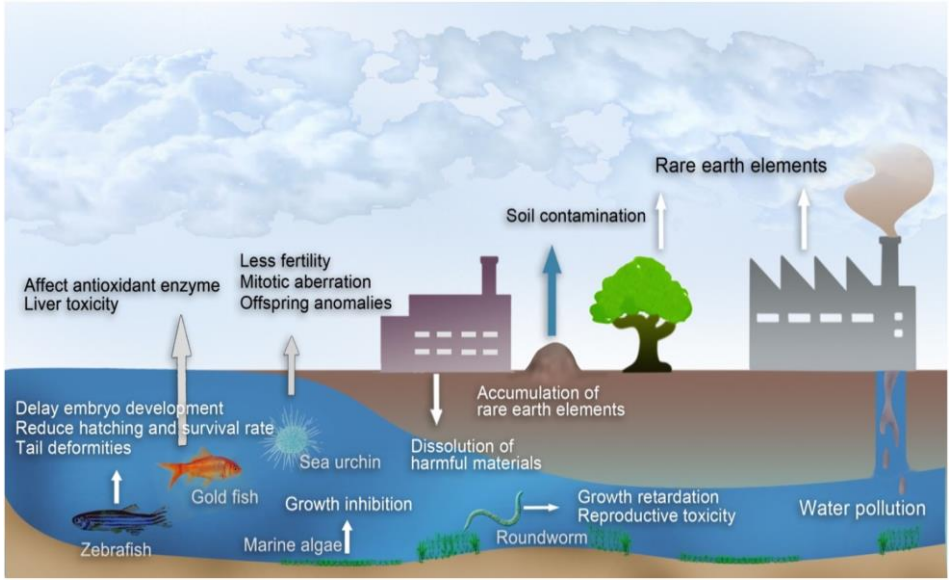
Sources of environmental release:

Mining activities ***industrial wastes***

plants, animals, and human health

Effects of REEs on human health

- ❑ Damage DNA
- ❑ Make urinary stones
- ❑ Genetic toxicity in bone marrow cells
- ❑ Damage the lung cells causing Pneumoconiosis
- ❑ Lower the blood clotting
- ❑ Lower IQ level leading to memory loss
- ❑ Kidney failure



REEs associated risks in aquatic species (DOI: 10.1016@j.envint.2019.03.022)

Problem Statement

Conventional analytical methods

- ICP-MS (Inductively Coupled Plasma Mass Spectrometry)
- ICP-AES (Inductively Coupled Plasma Atomic Emission Spectroscopy)
- NAA (Neutron Activation Analysis)
- XRF (X-ray Fluorescence)
- FFT-CCV (Fast Fourier Transform Continuous Cyclic Voltammetry)

Disadvantages

- Time-consuming
- High capital and operating costs
- Need for trained staff
- Sample preparation steps

Potentiometric sensors

- Cost effective
- Portable
- Real-time measurements
- High sensitivity
- Low detection limit
- Miniaturization capability
- Fast response

Purpose of study

The search for novel ligands to be employed in potentiometric sensors for REE quantification

Experimental

Membranes

PVC — Polymeric matrix (33 wt.%)

NPOE — Plasticizer (62-64 wt.%)

NaTFPB — Cation exchanger (10 mmol/kg)

S1 (ETH 129) / **S2 (ETH 5234)** — Neutral ligand (50 mmol/kg)

well-known commercial calcium ionophores

THF → **Parent membrane**

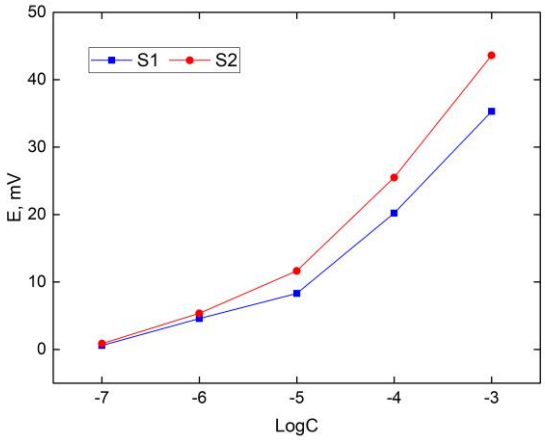
Electrochemical cell

Cu |Ag| AgCl, $KCl_{sa}t$ |sample solution| membrane |NaCl,0.01M| AgCl |Ag| Cu

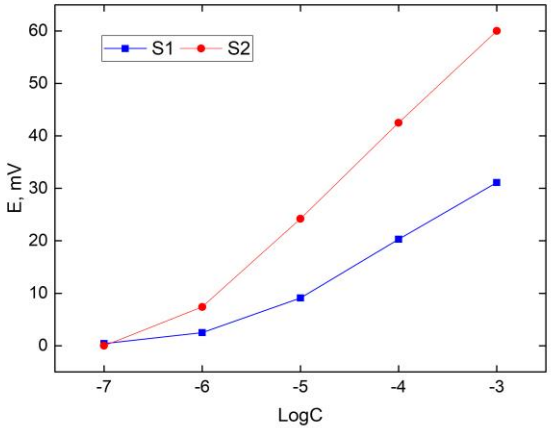
Results

Calibration was performed at 10^{-7} to 10^{-2}M of each ion
The linear part of each sensor function plot (10^{-5} to 10^{-3}M)

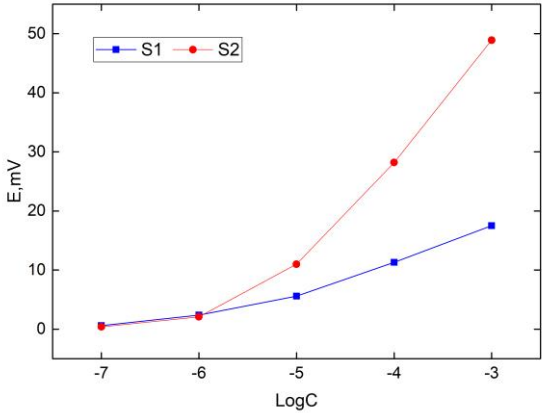
La^{3+}



Eu^{3+}



Lu^{3+}



Potentiometric response curve for REMs at pH=2

Sensors	La^{3+}	Eu^{3+}	Lu^{3+}
S1	13	11	6
S2	16	18	19
TODGA	10	16	20

Sensitivity values of the sensors to REMs ion at pH=2

Conclusion

- The possibility of using commercial calcium ionophores for the determination of lanthanum, europium, and lutetium was presented for the first time;
- Reproducible and stable results, high sensing performance, and low detection limits make them promising ligands for REMs analysis;
- ETH 5234-based sensor demonstrated pronounced sensitivity towards REMs at pH 2 in the linear range from pC=5 to pC=3;
- ETH 5234-based sensor showed similar behavior to TODGA.