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亲水性配体对放射性锕系元素的配位与分离

Abstract

Hydrophilic chelators are crucial for coordinating and separating radioactive elements in nuclear fuel recycling, hazardous waste treatment, environmental remediation, radiopharmaceuticals, and related fields. However, their development and understanding lag behind their lipophilic counterparts. This review summarizes the development of hydrophilic ligands across four categories based on their structural similarities and chronological order. For each category, representative examples are discussed, highlighting their advantages and disadvantages. The review also outlines current design challenges, and emphasizes the importance of establishing structure-function relationships to guide future ligand design. Additionally, we propose four novel f-block chelating ligands, some of which have shown efficiency in solid-liquid radionuclide separation, aiming to inspire the search for more robust systems for f-block element utilization and recycling. This review aims to provide a comprehensive overview of hydrophilic f-block element chelators and suggest promising approaches for future ligand development.

Keywords

hydrophilic ligands; solution coordination chemistry; lanthanides/actinides separation; acid resistance; nuclear waste management

摘要

亲水性配体对于核燃料循环、废物处理、环境修复、核药等相关领域中的放射性元素的配位和分离至关重要。然而其发展和研究程度落后于亲脂性配体。本研究根据配体的结构相似性和研究历程，总结了四类亲水性配体的发展情况。对于每一类亲水性配体，讨论了典型研究案例并详细论述了其优缺点。同时本研究概述了当前亲水性配体设计面临的挑战，强调了建立构效关系以指导配体设计的重要性。此外，提出了四种新型的亲水性配体的构建策略，部分已在放射性核素固液分离中展现出有效性，以启发人们寻找更强大的系统来利用和回收放射性元素。本综述旨在全面概述亲水性 f 区元素螯合剂，并为未来配体开发提出有前景的方法。

关键词

亲水性配体；溶液配位化学；镧/锕分离；耐酸性；核废料管理

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