



Ligand-Assisted Separation of Rare Earth Elements via Capillary Electrophoresis

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Changing the World's Energy Future

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Abstract

Rare earth elements (REEs) are a class of critical materials vital in applications such as EVs, batteries, and defense weapons systems. These elements are found primarily in ores, and due to their similar chemical behavior, the challenge remains to find an effective means of separation. The addition of ligands of varying charge, size, denticity, etc. can help to increase separation, yet the mechanistic behavior and factors influencing separation are still poorly understood. Here, iminodiacetic acid (IDA) is used to exploit and maximize differences in electrophoretic mobilities between adjacent REEs. Mobilities and diffusion coefficients of REEs in aqueous media are measured via CE and are compared to MD and FEM simulations.

Key Questions

- How do ligand properties such as charge, denticity, and size affect REE transport?
- What, if any, influence does the counterion have on REE diffusion and mobility?
- Fundamentally, what makes a ligand suitable for effective REE separation?
- How can ligands be selected to favorably improve separation?

Experimental Strategy

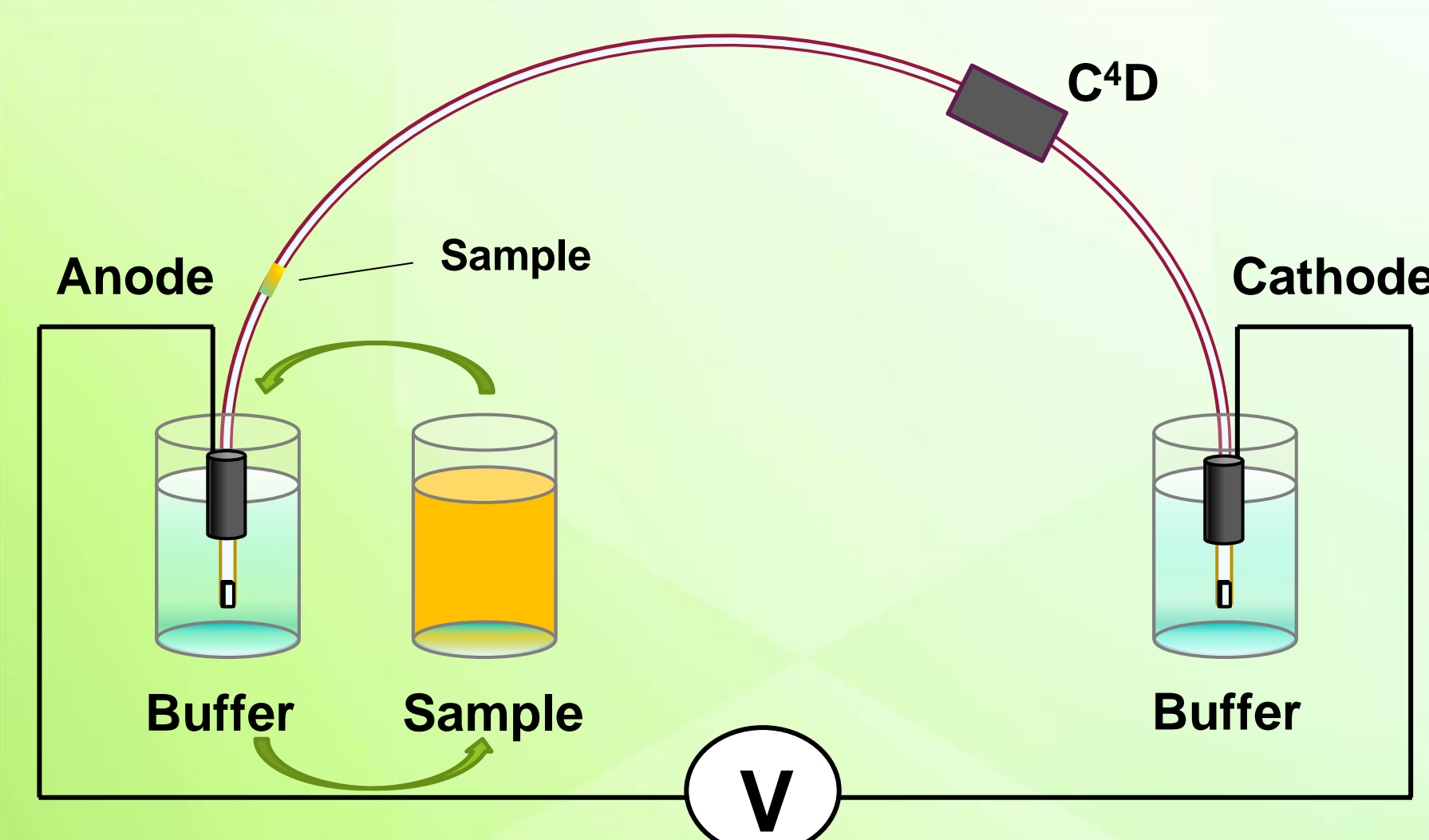


Fig. 1 A schematic representation of a typical CE setup.

Results and Discussion

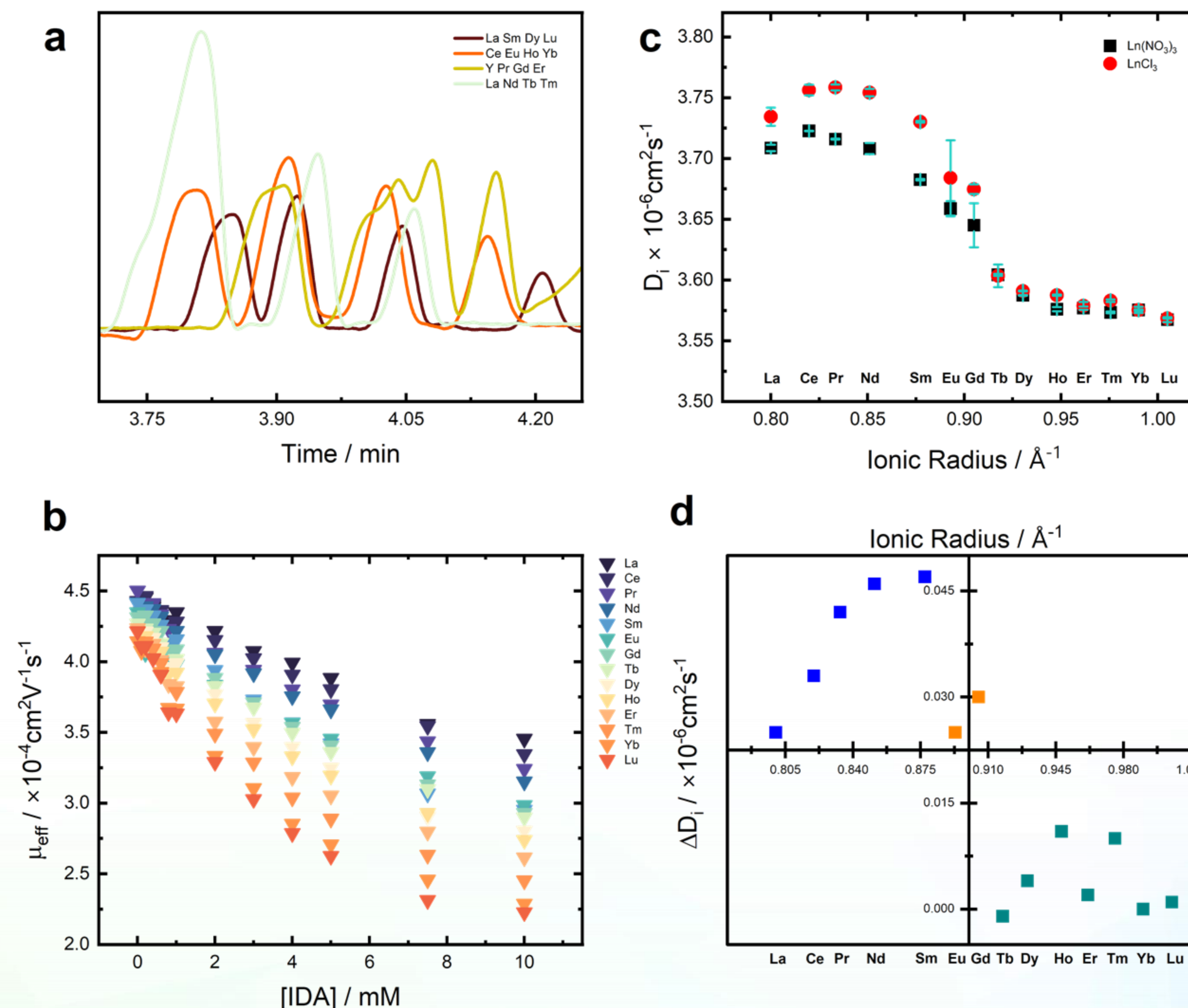


Fig. 2 Lanthanide nitrate and chloride electrophoretic data using IDA as a ligand for separation.

Conclusions and Future Work

- IDA can serve as a favorable ligand for REE separation, likely due to its partially complexing properties and speciation at the pH used
- The counterion seems to have a negligible effect on separation even when used in conjunction with a ligand
- Different ligand systems will be evaluated both experimentally and computationally to understand properties that influence REE transport

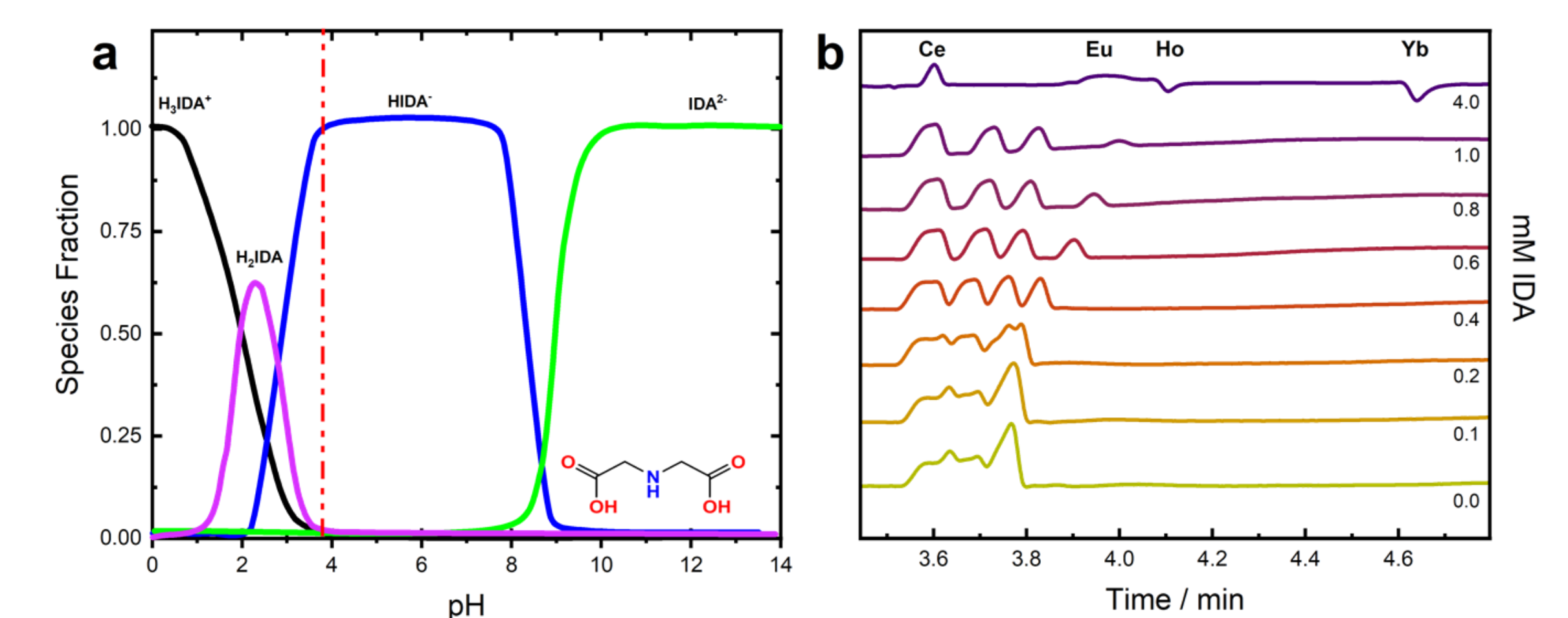


Fig. 3 IDA speciation and visualization of separation using IDA as a ligand.

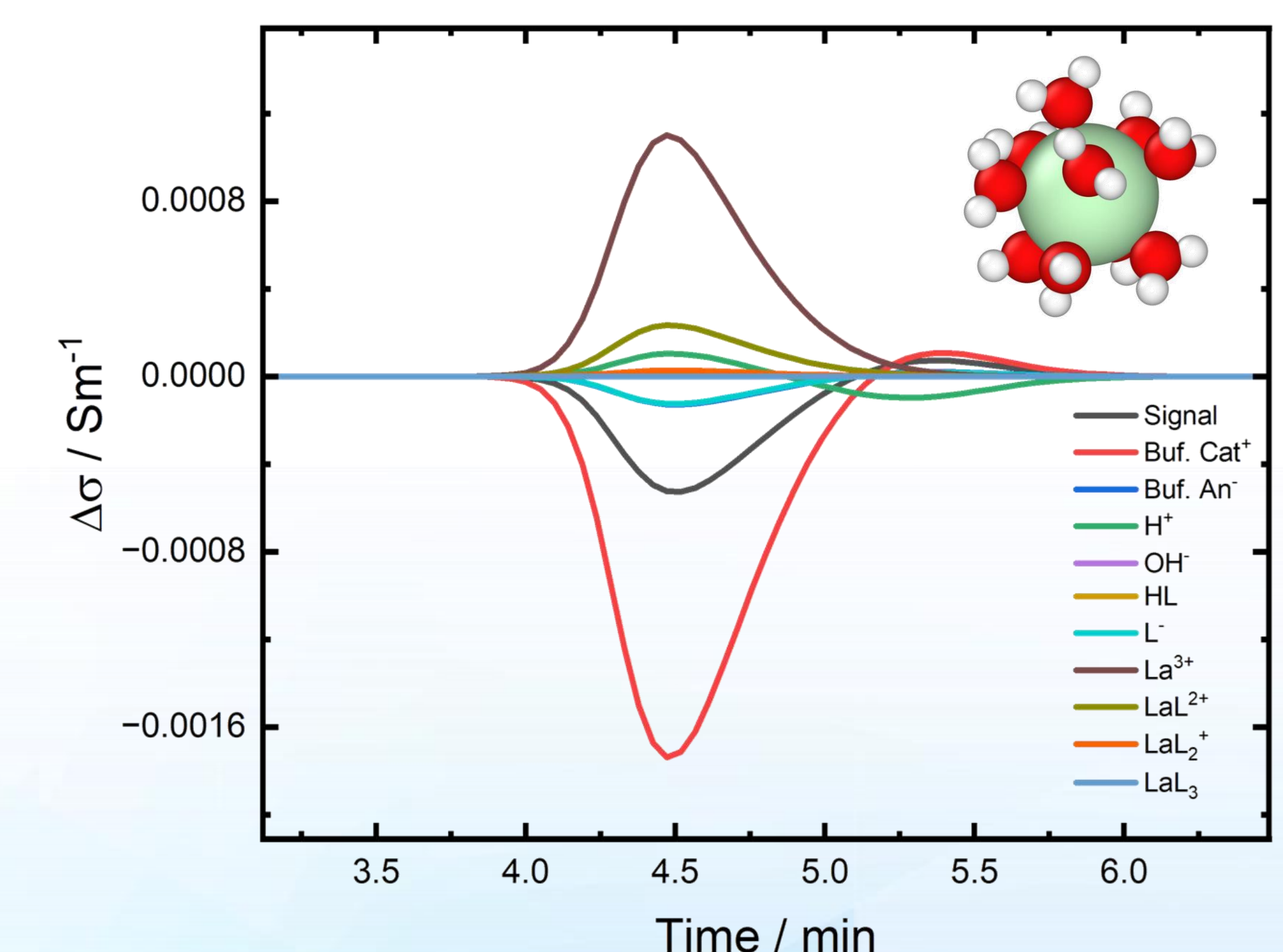


Fig. 4 Simulated CE data of a single 0.4 mM lanthanide in 0.6 mM ligand.

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