Non-Aqueous Free-Flow Electrophoresis Using Ionic Liquid Electrolyte

Yimo Liu, Sven Kochmann, and Sergey N. Krylov

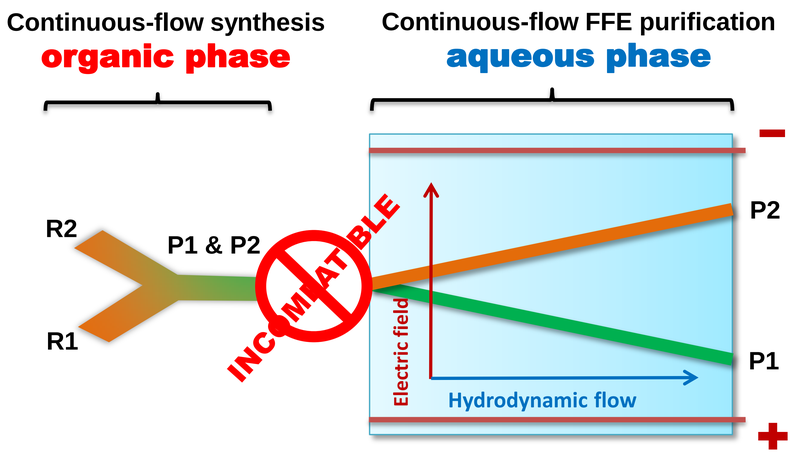
Department of Chemistry, Toronto, Ontario, Canada M3J 1P3

Introduction

Chip based free-flow electrophoresis (FFE) is a method for continuous separation of molecules in an electric field. It is an ideal tool for downstream purification of continuous-flow synthesis [1].

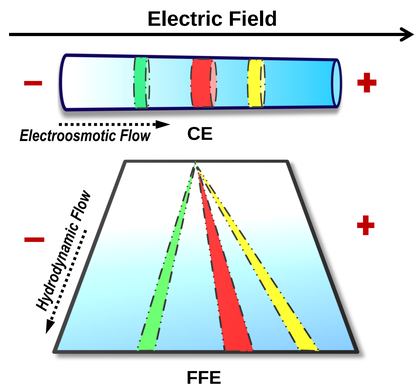
However, most organic synthesis reactions are done in organic environemnt, which are hardly compatible with aqueous-based separation methods like FFE. To adapt FFE method to more organic environemnt, we demonstrate the proof-of-principle application of acetonitrile based ionic liquid electrolyte in FFE separation as a first step toward establishing non-aqueous FFE as a purification tool for organic reactions.

Reaction: R1 + R2 ⟶ P1 + P2



From Non-Aqueous CE To FFE

Various non-aqueous electrolytes have been successfully applied in capillary electrophoresis (CE) for separation of hydrophobic organic compounds [2,3]. They can not only solvate hydrophobic anlaytes, but also possess wider range of acid/base strength to allow separations that are hard to achieve in aqueous media. Hence, from those electrolytes a list of potential candidates for non-aqueous FFE were selected and further tested in CE since they share similar principles of separration (Table 1).



Development

Step 1. Using CE to select effective non-aqueous electrolyte system that is able to:

- ✓ Achieve baseline separation of organic analytes
- ✓ Demonstrate separation selectivity through controlling anlayte mobility

Table 1. Non-aqueous electrolytes tested in CE for separation of organic compounds

Solvent	Ionic species	Baseline separation	Control Mobility
MeOH/ACN	ionic liquid	x	x
MeOH	ionic liquid	x	x
ACN	ionic liquid	✔	✔
ACN	acetic acid+tetrabutylammonium acetate	✔	x

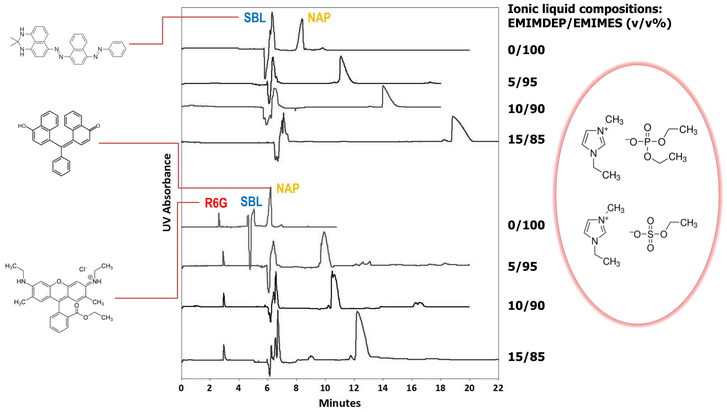
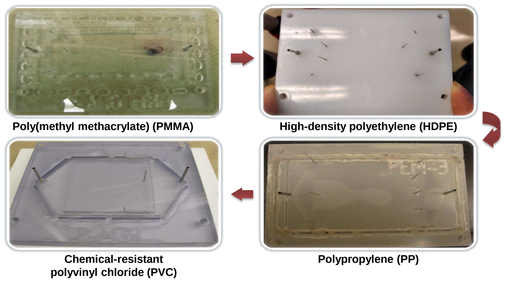


Figure 1. CE separation of 1mM rhodamine 6G (R6G), sudan black B (SBL) and α-naphtholbenzein (NAP) in 5mg/mL ionic liquid in acetonitrile (ACN). Electrolyte component: varying compositions of 1-ethyl-3-methylimidazolium ethyl sulfate (EMIMES) and 1-ethyl-3-methylimidazolium ethyl sulfate (EMIMDEP). Voltage: 18kV.

Step 2. Choose suitable raw material for FFE chip fabrication that is:

- ✓ Organic solvent-resistant
- ✓ Clear for visualization
- ✓ Machinable
- ✓ Economical



Preliminary Results

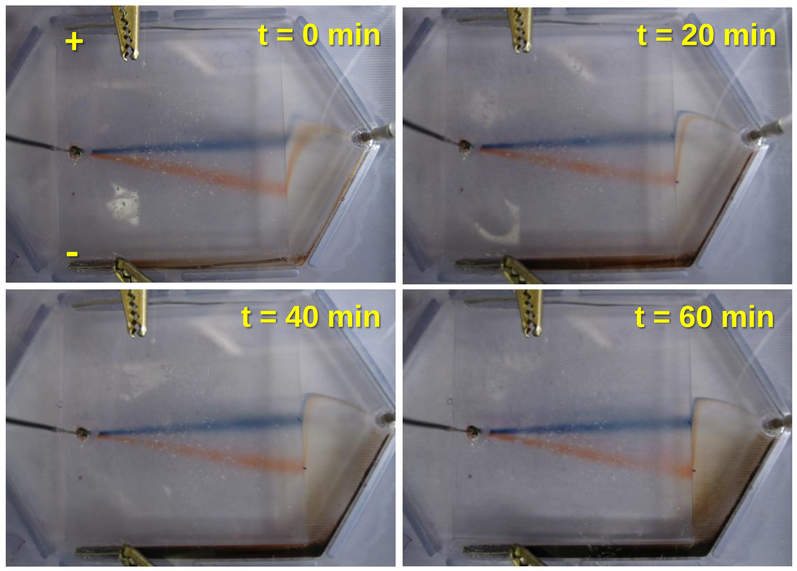


Figure 2. Continuous FFE separation of 3mM rhodamine 6G and sudan black B in 5mg/mL EMIMES in acetonitrile. Chip material: chemical-resistant PVC. Applied Voltage: 11V/cm.

Conclusions and Further Studies

From preliminary results:

- ✓ Acetonitrile based ionic liquid system serves as simple and effective electrolyte for non-aqueous FFE.
- ✓ Steady and precise non-aqueous FFE separation for 1h is achieved for the first time using the chosen electrolyte.

However,

- ❖ Separation stability and reproducibility needs further improvement.
- ❖ FFE separation of more samples and using different electrolyte compositions for controlling separation selectivity needs to be tested.

References

[1] F. J. Agostino et al. *Angew. Chem. Int. Ed.* **2013**, *52*, 7256−7260.

[2] M.-L. Riekkola et al. *J. Chromatogr. A.* **2000**, *892*, 155-170.

[3] M. Szumski, B. Buszewski, in *Electromigration techniques*, Springer, **2013**, pp. 203-213.

Group Page

Digital Poster