National Aeronautics and Space Administration

Novel Method for Analysis of Fatty Acids by Capillary Electrophoresis using Non-polar Solvents

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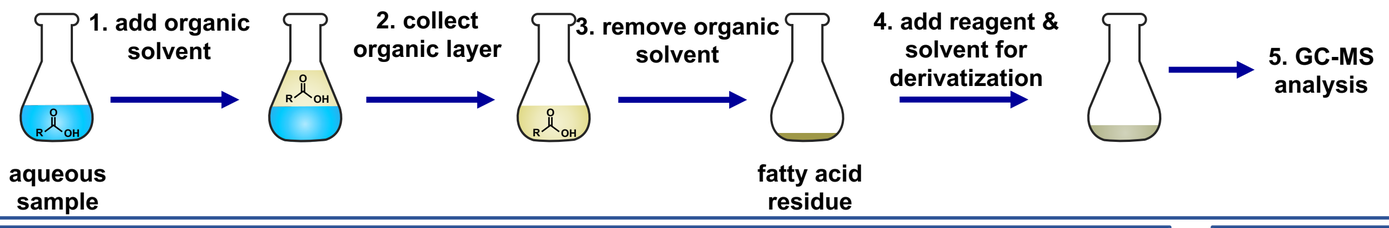
Program: FY22 R&TD Topics
Strategic Focus Area: Remote/In Situ/Life Detection Sensors and Instruments

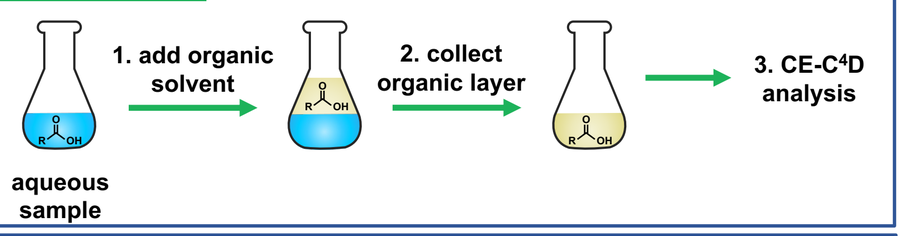
Project Goal: Development of a method for direct analysis of a wide range of fatty acids by capillary electrophoresis and contactless conductivity detection that minimizes sample preparation.

Approach and Results

Conventional approach

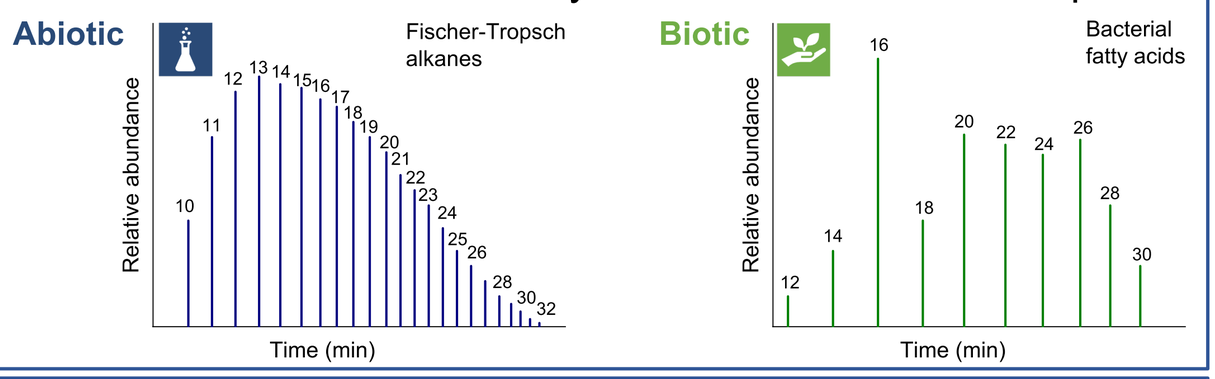


Our approach



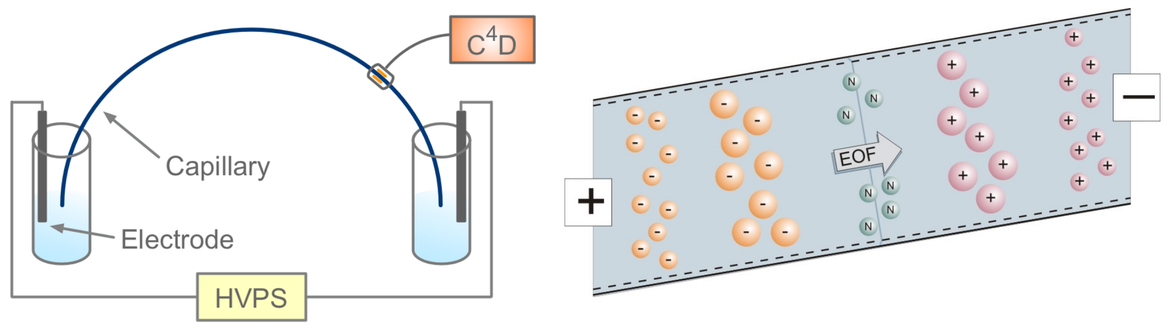
Background

Fatty acids are key targets for future in situ missions to ocean worlds looking for evidence of life. Fatty acids can be produced via abiotic and biotic processes resulting in different distributions. There is a need for a simple method to determine the relative abundances of fatty acids in ocean world samples.



Separation and detection of fatty acids with CE-C⁴D

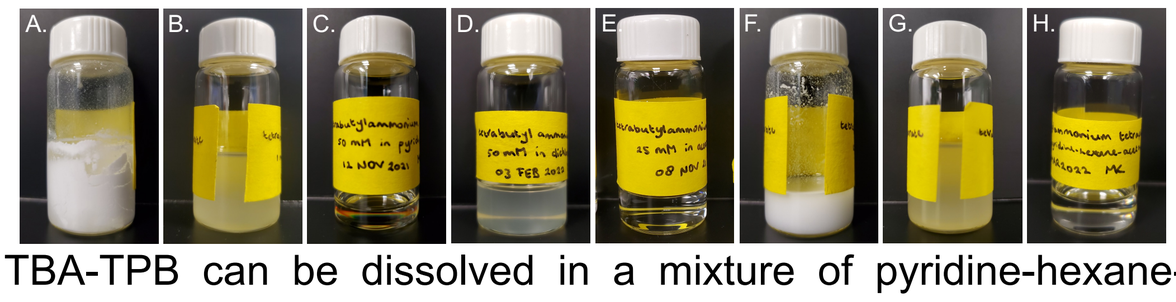
In CE, fatty acids are separated in an electrolyte based on their charge-to-size ratios. Charged fatty acids can be detected with C⁴D without the need for derivatization.



Selection of non-polar solvents for separation electrolyte

The challenge of using non-polar solvents is to find soluble electrolytes. We have studied the use of the hydrophobic salt tetrabutylammonium tetraphenylborate (TBA-TPB).

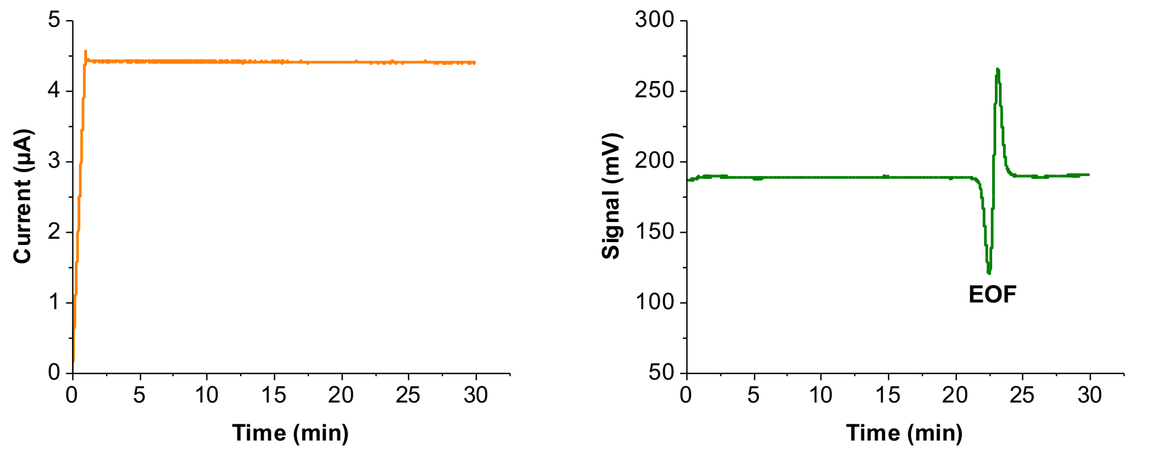
Solvent	Relative polarity	Dielectric constant	Dipole moment	Dissolves TBA-TPB?
hexane (A)	0.009	1.9	0	no
chloroform (B)	0.259	4.8	1	no
pyridine (C)	0.302	13	2.2	**yes**
1,2-dichloroethane (D)	0.327	10.4	1.8	no
acetone	0.355	21	2.85	**yes**
acetonitrile (E)	0.460	37.5	3.5	**yes**
isopropanol (F)	0.546	19	1.66	no
ethanol (G)	0.654	24	1.7	no
methanol	0.762	33	1.6	no
water	1	80.1	1.85	no



TBA-TPB can be dissolved in a mixture of pyridine-hexane-acetonitrile (4:2:4 v/v/v) (solution H).

Demonstration of electrophoresis

The use of 10 mM TBA-TPB in pyridine-hexane-acetonitrile (4:2:4 v/v/v) results in a stable **CE current** and **C⁴D signal**. So far, we have not obtained separation and detection of fatty acids, because they appeared to be uncharged under these conditions.



Future work

Optimization of the separation conditions for fatty acids using TBA-TPB in non-polar solvents. The use of additives is needed to deprotonate fatty acids, thereby allowing their separation and detection.

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Significance/Benefits to JPL and NASA:

The CE-C⁴D method developed for this project will overcome the limitations of GC-MS to detect FA and it will provide JPL with unique capabilities to detect organic biosignatures in samples collected during future missions focused on life detection.

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