



Signal Enhancement in Negative Ion Polarity Electrospray Using an Electrospray Membrane Probe



Shida Shen, Thomas White and Craig Whitehouse, Analytica of Branford, Inc., Branford, CT 06405



Introduction

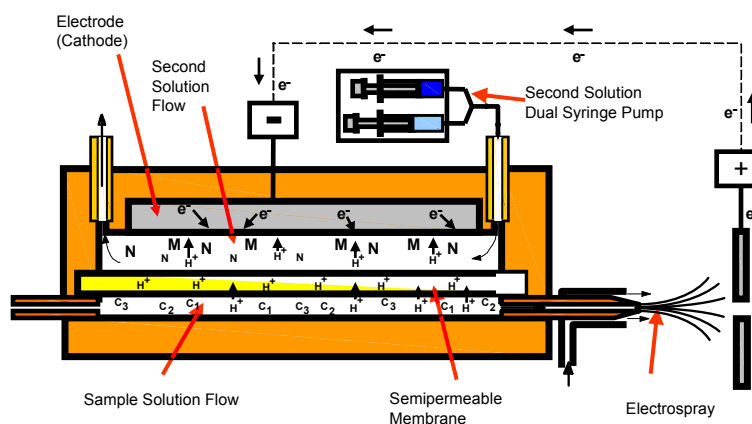
Up to a factor of fifteen in signal enhancement with negative ion polarity Electrospray has been obtained when using an Electrospray Membrane Probe compared with conventional Electrospray ionization. The sample solution flow channel is separated from a second solution flow by a semi permeable membrane in an Electrospray Membrane Probe. The Electrospray counter electrode is in contact with the second solution flow. Electrolyte and solvent composition of the second solution flow is changed or ramped during Electrospray ionization to change the total Electrospray current and sample solution pH. The current Membrane Probe study was conducted to assess the effect of removing the electrolyte from the sample solution in negative ion polarity Electrospray ionization using the Membrane ES Probe. ES/MS signal response was measured for different second solution electrolyte compositions and concentrations. Results were compared with conventional ES/MS negative ion polarity signal response.



Method

Proton exchange membranes, of different Nafion™ formulations and thickness, were installed in the Electrospray Membrane Probe for this study. The Electrospray Membrane Probe was interfaced to an Analytica Corsair™ Time-Of-Flight mass spectrometer. The Electrospray probe was operated at ground potential with pneumatic nebulization assist. Sample solutions of methanol/water and acetonitrile/water were Electrosprayed in negative ion polarity with electrolytes added to the ES Membrane Probe second solution. The second solution electrolyte concentration was ramped to scan the pH value and Electrospray total current at different organic to water solvent ratios to map Electrospray ionization efficiency. Different base and acid electrolyte species were run for a given sample with same concentration. Electrolytes were then added to the sample solution with conventional Electrospray and signal intensities were compared.

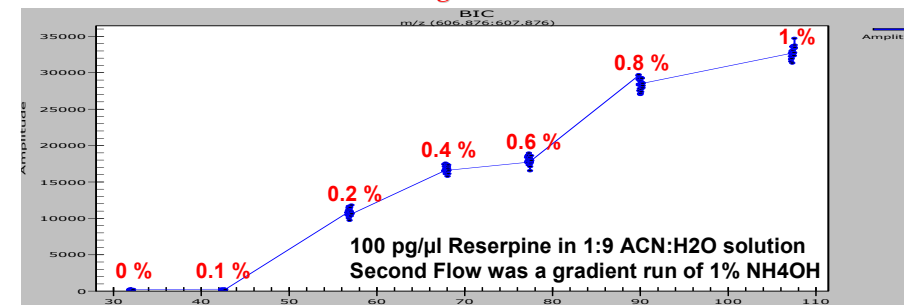
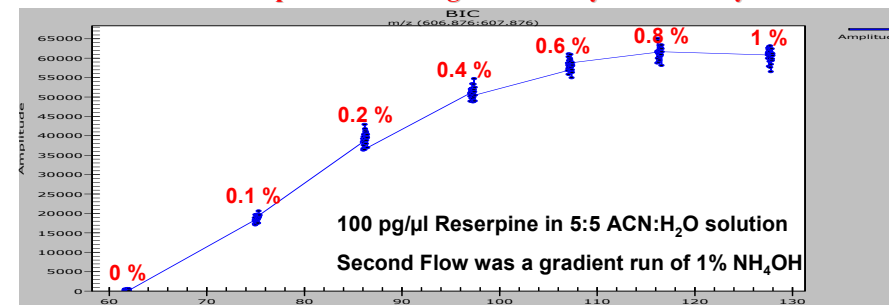
Electrospray Membrane Probe – Negative Ion Polarity



Experimental

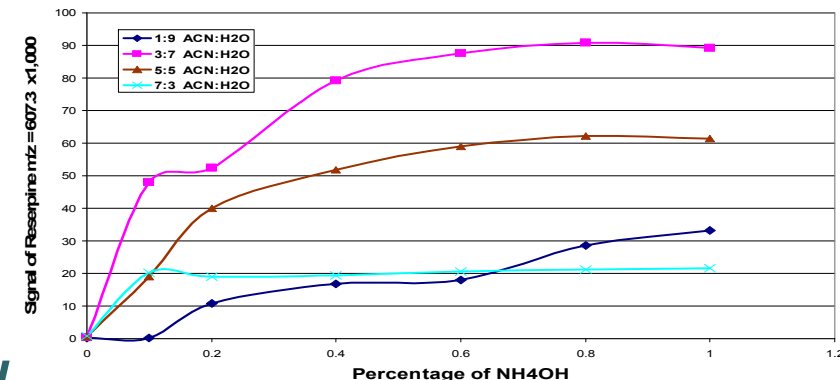
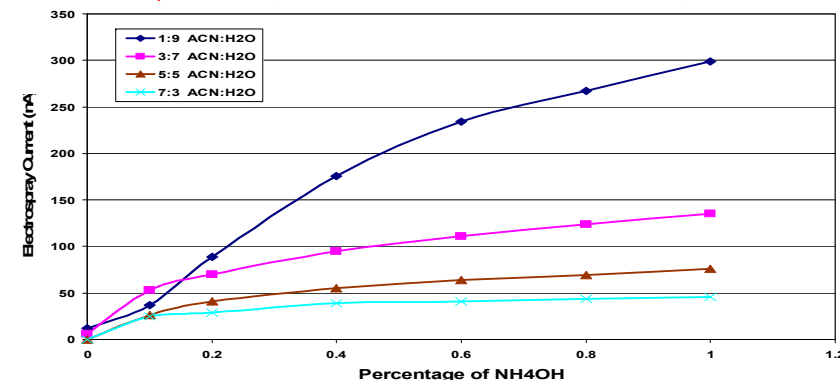
In negative ion polarity operation, protons move from the sample solution into the second solution during Electrospray operation. The movement of anions through the proton exchange membrane is greatly restricted. However, some electrolyte counter ions transport across the membrane occurs, likely driven by concentration gradients. The presence of the electrolyte counter ion, even in lower concentrations compared with the charge carrier, can have a significant affect on Electrospray ionization efficiency. In preliminary studies, Reserpine in acetonitrile/water and in methanol/water solutions was electrosprayed in negative ion polarity modes. Organic to water solvent ratios were varied from 10% to 70% during conventional Electrospray and Electrospray Membrane Probe operation. Ammonium hydroxide and sodium hydroxide electrolytes were added to the ES Membrane Probe second solution flow with the concentrations stepped from 0% to 1% by a dual syringe pump running in gradient mode during negative ion polarity Electrospray MS operation. Alternatively, the same electrolyte species were added to the sample solution at different concentrations and run using conventional negative ion polarity Electrospray.

The Dependence of Signal Intensity on Electrolyte Concentration in the Second Flow at Different Organic/Water Ratios Solutions



The Effect of ESI Current and Signal Intensity by the Solvent Composition in the Sample and the Electrolyte Concentration in the Second Flow

Sample Flow: 100 pg/μl Reserpine in various ratio of Acetonitrile/Water solution
Second Flow: NH₄OH in water, gradient mode concentration from 0% to 1%; Liquid Flow Rate: 10 μl/min

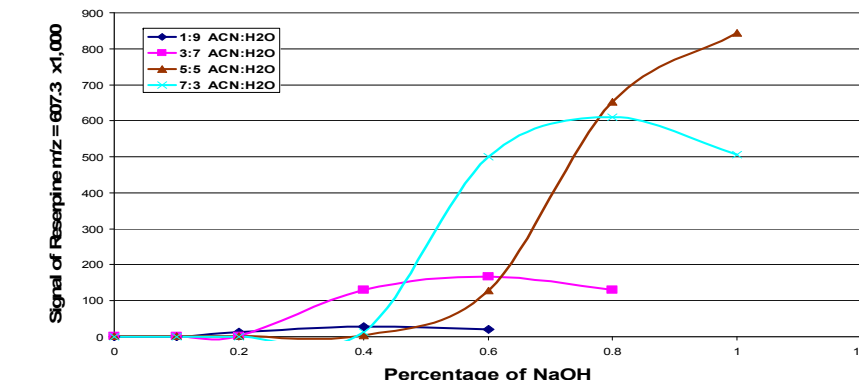
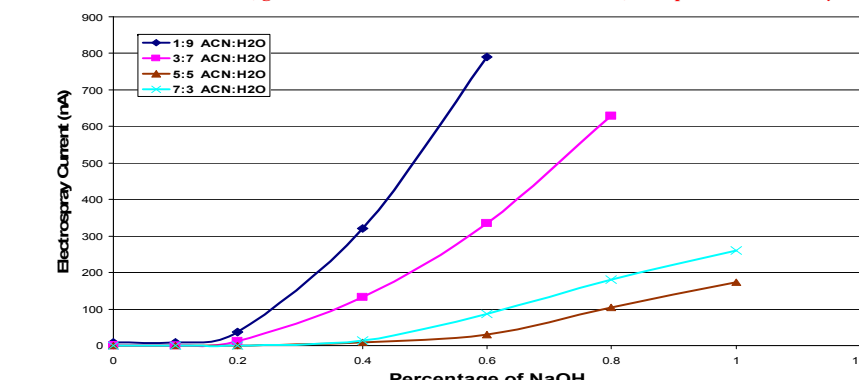


Results

- 1) Reserpine ES/MS signals increased by a factor of four when running ammonium hydroxide in the second solution of the Membrane Probe compared with conventional ES/MS where ammonium hydroxide was added directly to the sample solution.
- 2) Negative ion polarity reserpine signal increased by a factor of fifteen when reserpine was electrosprayed using an Electrospray Membrane Probe with Sodium Hydroxide added to the second solution compared with conventional Electrospray with sodium hydroxide solution added directly to the sample solution.
- 3) The Electrospray Membrane Probe operation can be used to improve analyte signal intensity in negative ion polarity ESI for selected solvent, electrolyte and sample solutions. The difference in performance between conventional negative ion polarity Electrospray and the Electrospray Membrane Probe performance sheds light on the fundamental processes of Electrospray ionization.

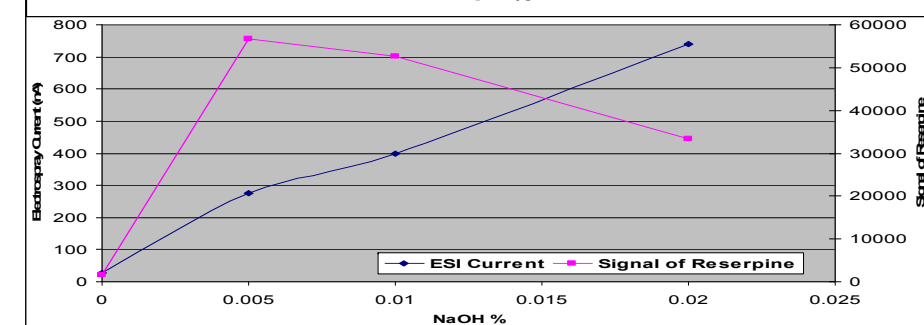
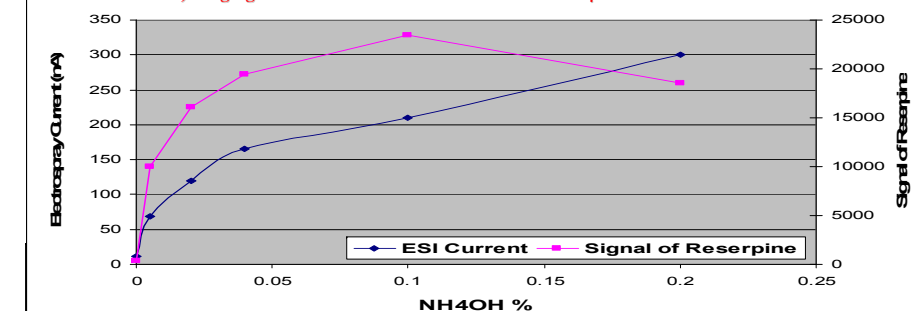
The Effect of ESI Current and Signal Intensity by the Solvent Composition in the Sample and the Electrolyte Concentration in the Second Flow

Sample Flow: 100 pg/μl Reserpine in various ratio of Acetonitrile/Water solution
Second Flow: NaOH in water, gradient mode concentration from 0% to 1%; Liquid Flow Rate: 10 μl/min



The Dependence of ESI Current and Signal Intensity in Conventional Electrospray, Adding the Electrolyte Directly in the Sample Solution

100 pg/μl Reserpine in 3:7 (5:5 lower graph) ACN:H₂O with various concentration of electrolyte (NH₄OH and NaOH) ranging from 0.005% to 0.2% at a flow rate of 10 μl/min



Performance Comparison of Membrane Probe vs. Conventional ESI Probe

100 pg/μl Reserpine in 3:7 (5:5 lower graph) ACN:H₂O with various concentration of electrolyte (NH₄OH and NaOH) ranging from 0.005% to 1.0% at a flow rate of 10 μl/min

