To the Plumes of Icy Moon and Elsewhere: *in situ* analysis of extraterrestrial organics and biomarkers using Miniature Electrochromatographic Monolithic Column (MEMoC). K. Fujishima[1], B. Carbonnier[2], M. Guerrouache[2], and L. J. Rothschild[3], [1]University Affiliated Research Center, NASA Ames Research Center, Moffett Field, CA 94035 USA. [2] University Paris-East (UPEC), Créteil, 94010 France, [3]NASA Ames Research Center, Moffett Field, CA 94035 USA.

Introduction: The *in situ* detection of organic molecules from extraterrestrial environments is a key step towards understanding the variety and distribution of the building blocks of life in space, specifically regarding future NASA space missions related to Europa and Enceladus. Gas chromatography/mass spectrometry (GC/MS) has been a successful and robust organic detection system for a number of missions including Viking, Curiosity and Rosetta. However GC is limited in that it can only be used to detect volatile and thermally stable molecules. Thus, it is not well suited for the detection of large molecular weight biomarkers such as polypeptides and oligonucleotides. Hence, we will investigate the potential of our newly developing Miniature Electrochromatographic Monolithic Columns (MEMoC) system to analyze molecules of exobiological interest.

A monolith is a single large "particle" that does not contain intra-particular voids. Monoliths will be designed via the free radical photopolymerization of a monomer (NAS) and cross-linker (EDMA) in the presence of an initiator (AIBN) and porogen (toluene) yielding 3D structured polymer consisting of small globuli fused together into micrometer-scale spheres forming a highly porous scaffold with a tortuous porous channel network [1]. Such monoliths provide easy surface chemistry tailoring allowing the design of stationary phases exhibiting fast mass transfer and versatile separation modes application. Such a two-step strategy has proved efficient for the preparation of monolithic stationary phases for reversed-phase, hydrophilic interaction, charge transfer and even the chiral electrochromatography [2].

Our long-term goal is to obtain a comprehensive reference peak list of various extraterrestrial organic compounds found in carbonaceous meteorites [3] and the interstellar medium [4] (amino acids, amines, aliphatic and aromatic hydrocarbons, sugars, phenols, alcohols, nucleobase, carboxylic acids, sulphonic acids) and possible biomarkers (peptides, oligonucleotides, metabolites). The detection of column-trapped organics will be accomplished by UV-visualization, but potentially monolith columns can be also coupled to MS as detector. We will challenge three major obstacles toward *in situ* analysis of biosignatures in space; 1) simultaneous probing of a large range of organic molecules, 2) investigation of large molecular weight biomarkers and, 3) addressing the capability for miniaturization. We look forward to share our preliminary results of separating various naturally-occuring peptides which could be found in the Europa/Enceladus icy plumes, and discuss the technical challenges regarding the *in situ* analytical system of such extraterestrial biosignatures.

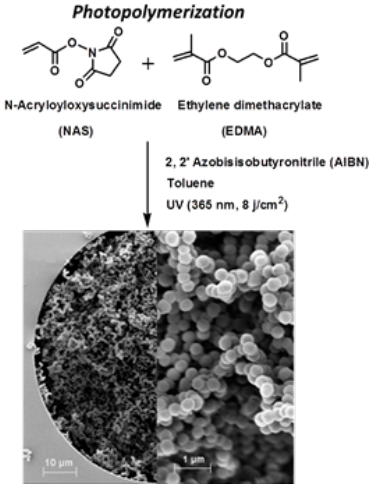

Figure: Preparation of generic monolith formed under photochemical polymerization.

References: [1] Guerrouache M. et al., (2007) *J Chromatogr A., 1149*, 368–376. [2] Guerrouache M., Millot M. C. and Carbonnier B. (2009) *Macromol Rapid Commun., 30,* 109–113. [3] Cooper G. et al., (2011). *Proc Nat Acad Sci USA, 108*, 14015–14020. [4] Nuevo M. *et al*., (2010). *Astrobiology, 10,* 245–256.