

MEMS-based Force-Detected Nuclear Magnetic Resonance Spectrometer system for Astrobiological Investigations

T. George, K. Son, C. Lee and P. R. Nilsson,

Jet Propulsion Laboratory, 4800 Oak Grove Drive, Pasadena, CA 91109-8099

R. A. Elgammal and D. P. Weitekamp

A. Noyes Laboratory of Chemical Physics, California Institute of Technology,
Pasadena , CA 91125

The proof-of-concept for a highly-miniaturized, Force-Detected Nuclear Magnetic Resonance (FDNMR) Spectrometer integrated with microfluidic sample extraction and handling is being developed under ASTID funding. Nuclear Magnetic Resonance (NMR) is the premier spectroscopic technique for the identification of organic compounds in solution. NMR spectrometers are ubiquitous in terrestrial chemical laboratories and are used extensively for elucidating the chemical structure, composition and bonding dynamics of organic molecules. Although attempts have been made in the past to miniaturize conventional NMR spectrometers, these approaches suffer from the very narrow range of molecular species that can be studied and the relatively large quantities of sample that are required. The proposed 2-mm diameter FDNMR spectrometer will be the world's smallest NMR detector capable of studying 60- μm -sized liquid samples, with superior sensitivity at these sample sizes in comparison to the conventional, inductive detection approach. It is envisaged that once the proof-of-principle for such a system has been demonstrated, it will be possible to develop "massively parallel" detection schemes involving several spectrometers mounted on a single microfluidics transport system, providing high-throughput, multiple analyses.

The development of an integrated FDNMR system will be undertaken over a period of three years. The first year effort is devoted primarily to the separate fabrication, assembly and testing of a MEMS FDNMR spectrometer and a micro-capillary based microfluidics sample transport system. We will report preliminary research results obtained from this work.