Gas detection using a MEMS TOF Mass-Spectrometer: First Results

Charles-Marie Tassetti[1], Romain Mahieu[2], Olivier Peyssonneaux[1], Jean-Sebastien Danel[2], Frederic Progent[1], Xavier Machuron-Mandard[1], Laurent Duraffourg[2]

[1]CEA, DAM, DIF, F-91297 Arpajon, France
[2]CEA, LETI, MINATEC CAMPUS, F-38054 Grenoble, France

A new generation of MEMS mass-spectrometers has been designed for gas analysis. These devices are fabricated using micro technology techniques: the fabrication process is mainly based on Deep Reactive Ion Etching (DRIE) of a silicon wafer, on a metallic layer deposition/patterning and on a silicon/glass wafer bonding technique. The chip is 1.5cm x 3cm. All the elements of a mass-spectrometer can be structured on the same die (ion source, electrostatic lenses, injection stage, analyzer). Two analyzer's configurations have been designed; one uses a simple drift zone and the other one uses a reflectron associated to a drift zone.

The ionizer uses the electron impact (EI) technique to ionize the injected gas sample. It produces ionic currents in the order of hundreds of pA up to several nA with maximum of 50 nA.

The linear TOF configuration - simple drift zone analyzer - has been tested using electron pulses of 50 ns to produce ions. Mono charged ions are accelerated in the focalization and have an energy of 70 to 200 eV, then they are injected in the drift zone which is 5 mm. A Photonis APD2 Minitof micro-channel-plates (MCP) detector is placed at the output. The detector's time dependant signal is recorded on a wideband oscilloscope synchronized by the electron pulse. The time-of-flight is between 0.5 to 4 µs for the injected gases.

This study has demonstrated the feasibility of the MEMS TOF mass-spectrometer. Mass spectra have been obtained on simple gases such as Helium, Argon, Krypton, Xenon and Ethanol. This micro mass-spectrometer has a resolving power close to 1 over a mass range of 1 to 100 Da.

Further improvements consisting in using the reflectron - and connecting the MEMS mass-spectrometer to a chromatograph - are in progress.