Membrance Interface Evaluations for Underwater Mass Spectrometers

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A component that has enabled the development of underwater mass spectrometry is a mechanically supported membrane interface probe. Our two research groups have used metallic porous frits that support polydimethyl siloxane (PDMS) membranes embedded in a heated membrane probe assembly, allowing the deployment of the underwater membrane introduction mass spectrometer (MIMS) instruments to ocean depths of 2000 meters. The fabrication of such frits has consisted of shaping larger Hastalloy C porous frits to the size required to support a PDMS capillary of 0.64 mm ID and 1.19 mm OD using a diamond-coated wheel and Dremel tool. This procedure is time-consuming and cumbersome, and the porosity of the final frits is likely not reproducible. To facilitate the fabrication of the membrane assembly, we report on the use of new porous metallic structures. Frits with diameters of approximately 3.0 mm (1/8”) and known porosities (48.3 % and 32.5%) were produced by the Fraunhofer Institute in Dresden, Germany, using powder metallurgical processes. We used these frits to fabricate new membrane interface assemblies. Using a new custom-heated membrane probe with the new porous frits, we performed calibrations relating dissolved methane concentrations to mass spectrometer response (m/z 15) using linear least-squares fitting procedures. Both the limit of detection (methane concentration in the tens of nanomolars) and the sensitivity (on the order of 10^{-1} pico-amps/nanomole of methane) were found to be comparable with those obtained with the previously fabricated Hastelloy C frits. The calibration parameters for the new assembly were also found to be a function of the flow rate, temperature, and sample hydrostatic pressure.