TECHNICAL NOTE

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Wet Cell II Liquid Probe System for SEM/EDS, EPMA and TOF-SIMS

Introduction

The liquid interfaces are very active and important for environmental, biological, and industrial processes. However, most surface analysis instrument are vacuum based and the rapid liquid evaporation makes in-situ analyzing liquid surface extreme challenge.

Wet Cell II offers a simple solution for scientists and researchers to directly analysis of liquids at the molecular level in a vacuum environment with minor cost. As a lab-on-a-chip device, Wet Cell II can be straightforwardly adaptable to many different analytical platforms, including scanning electron microscopy (SEM) and time-of-flight secondary ion mass spectrometry (TOF-SIMS). The device can be used for in-situ chemical probing or molecular imaging of a sample in liquid.

Limitations of Other Approaches

Approaches	Limitations
Liquid Jet	▪ Too much water load ▪ Severe cooling
ESEM and In-situ XPS	▪ Specially built instrument ▪ Cannot handle highly reactive gaseous environments ▪ Will not work much above ~25 Torr
Wet TEM Cell	▪ Cell to encapsulate the liquid will block the signals significantly ▪ Only used in TEM

System Components

Figure 1. Top view of Wet Cell II

- 70x94 mm Metal base plate
- Electrical control board
- Micropump
- Battery
- Microfluidic block
- SiN or SiO_2 membrane
- Vacuum compatible tubing

How Does Wet Cell II Operate?

Wet Cell II is a self-contained lab-on-a-chip device. It doesn't require any external wires or tubing connections and thus there is no need for modification of the existing microscope. The device only consumes a few drops (100-200

microliters) of liquid sample, which can be loaded into the system either by the micropump on Wet Cell II or a syringe pump.

The sample liquid is circulated by a battery-powered micropump with flow rate of 1-2 ul/min. 2-3 microns aperture is opened on the SiN membrane using a focused ion beam for in-situ imaging and chemical analysis the liquid through the narrow microchannel. Wet Cell II can continuously flow the liquids for up to 4 hours, which can satisfy the most liquid analysis experiments.

The strong surface tension of the fluid across the opening and the fast flowing liquid through the narrow microchannel has the following advantages:

1. The liquid evaporation can be sufficiently suppressed.
2. The beam damage on the fluid can be significantly reduced.
3. The sample under the aperture is always refreshed and thus the memory effect can be greatly prevented.

"Using Wet Cell II, some complex liquids encountered in industry and science has been analyzed. These liquids included organic solvents in a water-based solution and gold nanoparticles united with antibodies in a water-based buffer solution. Even under the intense beam bombardment in the scientific analytic platforms such as SEM and Tof-SIMS, Wet Cell II can continuously flow the liquid samples for hours without any significant beam damage. The results provided better and more multifaceted characterization of the nanoparticles suspended in solution and the solvent itself in the high-vacuum mode than experiments with conventional dry or wetted samples in the more-often used environmental SEM (ESEM)." [1]

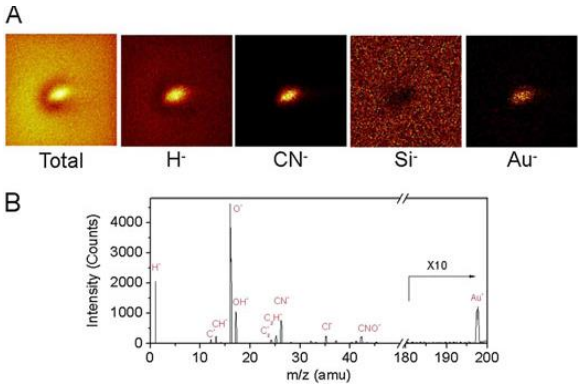

Figure 2. (A) Secondary negative ion images around the aperture area with 5 nm goat anti-mouse IgG nanoparticles solution in the channel. (B) ToF-SIMS negative ion m/z spectrum in the aperture. [1]

Specifications

- Self-contained high vacuum compatible device
- Battery driven pump for >4 hours operation
- Microfluidic block for sample characterization
- Electron transparent SiN membrane
- ~100 ul reservoir
- Flow rate <2 ul/min
- Low cost replaceable components allow
- contaminant free work
- Platform size: 70 x 94 mm
- Height: 18 mm

References:

1. Yang, L., Zhu, Z., Yu, X. Y., Rodek, E., Saraf, L., Thevuthasan, T., & Cowin, J. P. (2014). In situ SEM and ToF-SIMS analysis of IgG conjugated gold nanoparticles at aqueous surfaces. *Surface and Interface Analysis*, 46(4), 224-228.