

1 *Microfluidic cells for transmission electron microscopy (TEM) on carrier frame*

## IN SITU (S)TEM OF SPECIMENS IN LIQUID ENVIRONMENT

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#### Characterization of nanomaterials in liquids under high vacuum conditions

Microfluidic cells enable in situ electron microscopy of solvent-dispersed nanomaterials or solid / liquid interface reactions in a defined environment.

The analyzed fluid is confined between electron-transparent membranes supported by a mechanically stable body, analyte reservoirs, and supply channels\*.

#### Use cases

Typical applications include but are not limited to

- characterization of nanoparticles in liquid host systems
- studies into particle-particle interactions
- investigation into surface reactions on particles or membranes
- growth, stability and degradation processes of arbitrary nanomaterials

#### Bulk micromachined microfluidic devices

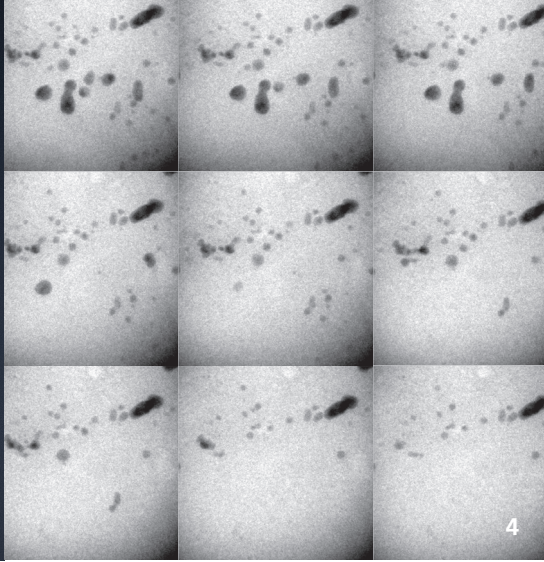
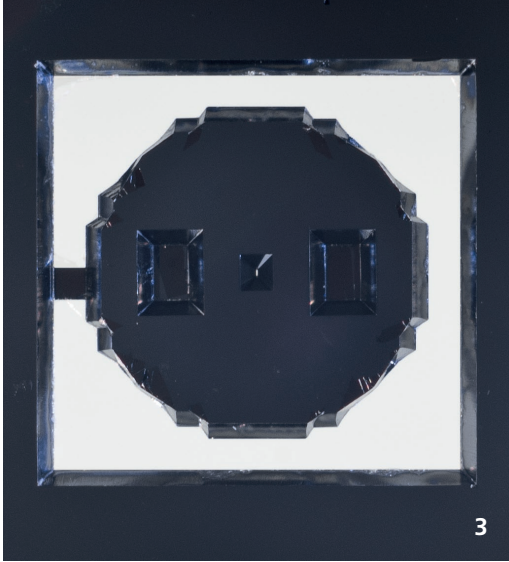
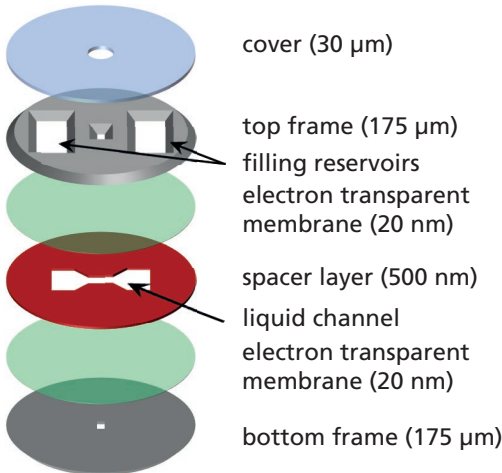
The fabrication of liquid cells for (S)TEM is based on the qualified silicon fabrication environment of Fraunhofer IISB. The cells have been developed by integrating a range of CMOS-compatible microfabrication steps with bulk micromachining techniques.

#### Application specific customization

Fraunhofer IISB key factors enable the supply of tailor-made solutions for your microfluidic application:

- A vast range of available process techniques and thin-film materials like Micro- and Nanopatterning, Bulk etching techniques, and PVD/CVD techniques
- The sound understanding of process integration and physics/chemistry of micro- and nanodevices acquired from 30 years in microelectronics research.

\*See back page for detailed information



2

3

4

2 Concept of a microfluidic cell for (S)TEM

3 Top view of liquid cell with shine-through observation window

4 Electron-beam induced dissolution of gold-nanoparticles in aqueous  $\text{HAuCl}_4$ -solution

# BULK MICROMACHINED LIQUID CELL FOR IN SITU (S)TEM

## Cell concept

The cell is built from two bonded silicon wafers acting as mechanically stable body. Membranes are made from layers of amorphous silicon nitride. For filling of the cell, a channel connects the analytical window to reservoirs.

## Specific data

Sample holder: conventional TEM specimen holder capable to cell thickness	Observation window: 10 µm x 50 µm
Cell size: 2.9 to 3.1 mm	Channel thickness: 100 nm to 10 µm
Fluid volume: ~200 nl	Cell thickness: 350 µm*

\*advanced cell designs with 175 µm possible

## Services

- Customization
  - cell layout
  - cell design (e.g. graphene- or microwell-based)
- Integration with add-on features
- Development of microfluidic systems:
  - Micro reaction technology
  - Lab-on-chip, nanopatterned assay plates and carriers