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Novel Micro-fabricated Chip With Micro-channels for In-situ Observation of Liquid Samples and Processes in TEM

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Developing a new in-situ chip

With the resolution of TEM reaching atomic scale increasing emphasis is being placed on ways to image samples live and under realistic conditions; it is therefore necessary to broaden the scope of electron microscopy to non-traditional samples such as liquids. State of the art systems use a sandwich approach of two identical chips with electron transparent windows. In this work we present a monolithic design which avoids the alignment and bulging issues of such systems.

Fabrication and Characterization

The chip was fabricated using standard cleanroom fabrication techniques. The channel was defined in a sacrificial Si layer, covered with SiNx, and then etched out. To ensure mechanical stability the top layer of SiNx was 175 nm thick and selected areas of the channel on the membrane were thinned down with an anisotropic etch to 25 nm to create thinner window regions. In this first prototype, the channel was 700 nm thick with 25 nm SiNx above and below it. AFM scans, optical images, and COMSOL simulations were used to characterize the prototype.

TEM imaging and Conclusion

The TEM chip prototype was filled with a liquid containing 30 nm diameter Au nanoparticles (NP) and placed in a standard TEM holder. Images of the TEM chip were taken in a Technai T20 G2. The inlets of the channel, through which the liquid was introduced, were sealed with an acrylic varnish which dried and removed some of the liquid in the channel, resulting in bubbles. This prototype has proven to significantly reduce sample preparation time for liquids and allows for simply imaging of liquids in the TEM. Future versions will have reduced the channel height to improve the achievable resolution and include various active components such as heaters and electrodes. This work is being submitted to a special issue of the Journal of Microscopy and Microanalysis. In addition to this TEM system we are also developing an in-situ SEM electrochemical setup.

References