Microchip systems for imaging liquid and high temperature processes in TEM & SEM

Microchip systems have found their way into electron microscopes in order to make miniature platforms for controlled liquid and gaseous environments that also begin to include electrical contacts and other types of interactions with the sample, such as application of forces and irradiation with light. This presentation will explain the different types of microchip systems and give examples of some of the results we have achieved with our devices and examples of how such devices can be used for research related to energy storage and conversion. Heaters can be made in several ways, and monocrystalline silicon cantilever heaters have successfully been used to grow silicon nanowires in-situ TEM to create an electrically contacted nanowire bridge between two cantilevers. This makes it possible to make IV measurements of the pristine wires [1]. Such heaters might find use for heated and electrically contacted measurements on high temperature fuel cell systems. For imaging processes in liquids, our SEM system enables imaging on-chip microelectrodes and using standard built-in reference electrodes [2]. To get higher resolution in TEM, we have created a monolithic chip system with suspended microfabricated channels [3]. Both systems will allow high resolution imaging of heterogeneous electrochemical processes such as those in batteries. Based on the suspended microfluidic channels, we are also developing microchips that enable ultrafast freezing of processes in liquids.