Blotting-free micropatterned chip for cryo-TEM imaging of materials in native environments

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Recent advances in cryogenic transmission electron microscopy (cryo-TEM) enable high-resolution analysis of various protein structures and air- or radiation-sensitive materials. In order to obtain high-resolution cryo-TEM images, specimen must be fixed in a homogeneous, tens-of-nanometers-thick vitreous ice layer. However, the blotting process in conventional sampling procedures poses challenges in controlling the thickness and homogeneity of ice, and accompanies air-water interfacial damage of the specimen or sample loss to the blotting pad. Herein, we develop a blotting-free, silicon (Si) based device with nanometer-scale-thick silicon nitride (Si_xN_y) microchannels and a reservoir using the microelectromechanical system (MEMS) technique, and equip the device with graphene oxide viewing windows. This newly developed microchannel device eliminates the blotting procedure by allowing the specimen-containing solution to flow through the microchannels with precisely controlled depths. The device is customized to produce ice layers with thicknesses between 50 to 100 nm for imaging various inorganic, polymeric, and biological materials.