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Thickness-dependent dielectric breakdown and nanopore creation on sub-10-nm-thick SiN membranes in KCl aqueous solution ITARU YANAGI, KOJI FUJISAKI, HIROTAKA HAMAMURA, KENICHI TAKEDA, Hitachi,Ltd. — Recently, dielectric breakdown of solid-state membranes in solution has come to be known as a powerful method for fabricating nanopore sensors. This method has enabled stable fabrication of nanopores down to sub-2 nm in diameter, which can be used to detect the sizes and structures of small molecules. Until now, the behavior of dielectric breakdown for nanopore creation in SiN membranes with thicknesses of less than 10 nm has not been studied, while thinner nanopore membranes are preferable for nanopore sensors in terms of spatial resolution. In the present study, the thickness dependence of the dielectric breakdown of sub-10-nm-thick SiN membranes in solution was investigated using a method developed herein called gradually increased voltage pulse injection. The increment in leakage current through the membrane at the breakdown was found to become smaller with a decrease in the thickness of the membrane, which resulted in the creation of smaller nanopores. In addition, the electric field for dielectric breakdown drastically decreased when the thickness of the membrane was less than 5 nm. These breakdown behaviors are quite similar to those observed in gate insulators of metal-oxide-semiconductor (MOS) devices.

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