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Precise Fabrication of Nanopores with Diameters of Sub-1 nm to 3 nm Using Multilevel Pulse-voltage Injection ITARU YANAGI, RENA AKAHORI, TAKAHIDE YOKOI, KEN-ICHI TAKEDA, Central Research Laboratory, Hitachi Ltd — To date, solid-state nanopores have been fabricated primarily through a focused-electronic beam via TEM. For mass production, however, a TEM beam is not suitable and an alternative fabrication method is required. Recently, a simple nanopore-fabrication method has been reported that is based on a dielectric breakdown phenomenon of a thin membrane. In this study, to stably fabricate nanopores with diameters of 1 to 2 nm (which is an essential size for distinguishing each nucleotide) via dielectric breakdown, a technique called multilevel pulse-voltage injection (MPVI) is proposed and demonstrated. MPVI uses pulse voltages for generating the nanopores, and the generation of the nanopores is verified by measuring the current through a membrane at low voltage. This method can generate nanopores with diameters of less than 1 nm in a 10-nm-thick Si_3N_4 membrane with a probability of 90%. The diameter of the generated nanopores can be widened to the desired diameters (up to 3 nm) with sub-nanometre precision. The mean effective thickness of the fabricated nanopores was 3.7 nm. These findings are derived from TEM images of the fabricated nanopores and analyses of ionic-current blockades during single-stranded DNA translocation.

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