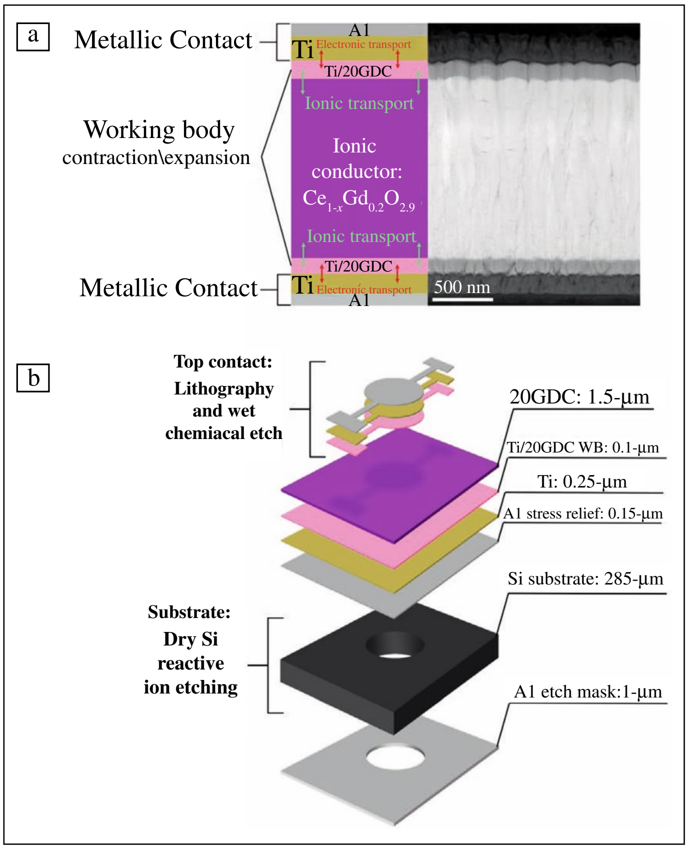
All solid state electro–chemo-mechanical actuator operates at room temperature

A research group from the Weizmann Institute of Science, Israel, and Stony Brook University, USA, has developed a room-temperature Si-compatible electrochemomechanical (ECM) membrane actuator, as reported in a recent issue of *Advanced Functional Materials* (https://doi.org/10.1002/adfm.202006712). Despite the benefits of piezoelectrics and electrostrictors, regulations and restrictions arise due to the toxicity of Pb in these materials which is motivating researchers to create new methods to generate electromechanical response.



Scheme of the electrochemomechanical actuator showing (a) its basic elements and practical realization; the transmission electron micrograph shows a 70–100-nm-thick cross section slice of the multilayer stack deposited on a Si substrate; and (b) representation of the sputtered layer stack. Credit: *Advanced Functional Materials.*

ECM produces a change in the mechanical dimensions of ionic and mixed ionic-electronic conductors, and occurs as the electric field triggers a change in chemical composition. Igor Lubomirsky, Anatoly I. Frenkel, and colleagues provide a practical application of the ECM concept in a prototype of an ECM-based membrane actuator that provides micron-size displacements and long-term stability. Their ECM device consists of a "working body" of 20 mol% Gd-doped ceria ($Gd_{0.2}Ce_{0.8}O_{1.9}$ or 20GDC) sandwiched between two Ti thin-film metal contacts.

The pseudo "piezoelectric" coefficient of the stacked layer membrane is estimated to be >1.25 C m^{-2}, which is comparable to the values for lead-free piezoelectrics such as lithium niobate, sodium potassium niobate, and bismuth alkali. The ECM has the feature of mass transport controlled by current and the buckled membrane temporarily retains its shape after the DC voltage is removed.

Lubomirsky says, "The paper shows a new concept: generation of stress and strain by controlled change in composition. This [has] never been done before in an all-solid-state device. This is a precedent that may give rise to a new field."

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