Electro-mechanically controlled assembly of reconfigurable 3D mesostructures and electronic devices based on dielectric elastomer platforms

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Background

The manufacture of 3D mesostructures is receiving rapidly increasing attention, because of the fundamental significance and practical applications across wide-ranging areas. The recently developed approach of buckling-guided assembly allows deterministic formation of complex 3D mesostructures in a broad set of functional materials, with feature sizes spanning nano-scale to centimeter-scale. Previous studies mostly exploited mechanically controlled assembly platforms using elastomer substrates, which limits the capabilities to achieve on-demand local assembly, and to reshape assembled mesostructures into distinct 3D configurations.

Methods

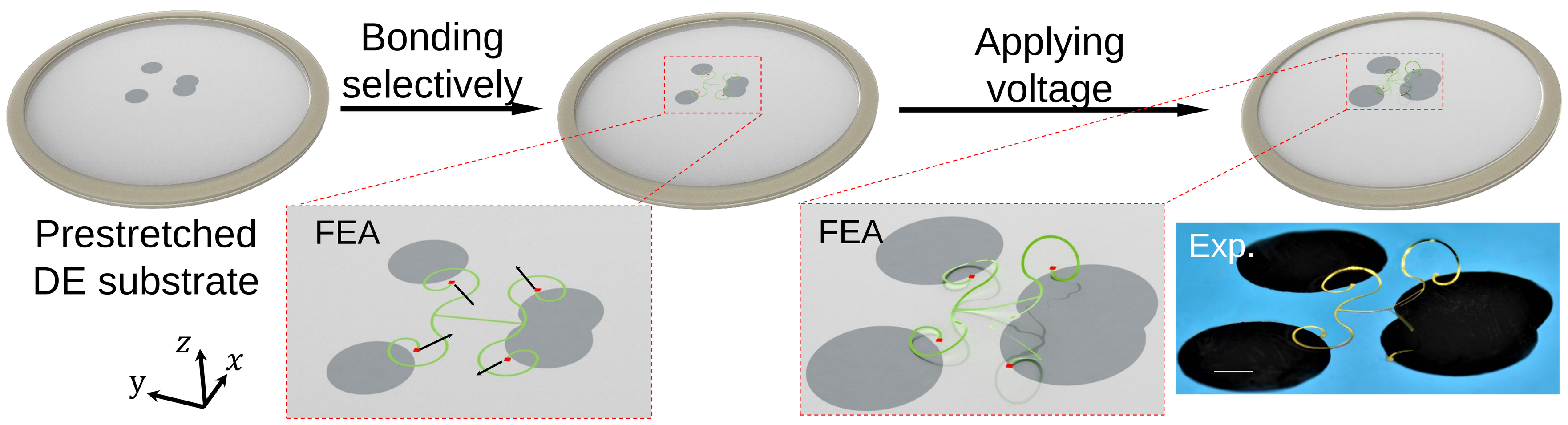


Figure 1 illustrates the basic concept of the reported electro-mechanically controlled assembly, based on Dielectric Elastomer Actuators as the assembly platform. In this strategy, in-plane strain distribution of DE induces 2D precursor into 3D configuration rapidly (< 1 s) and reversibly.

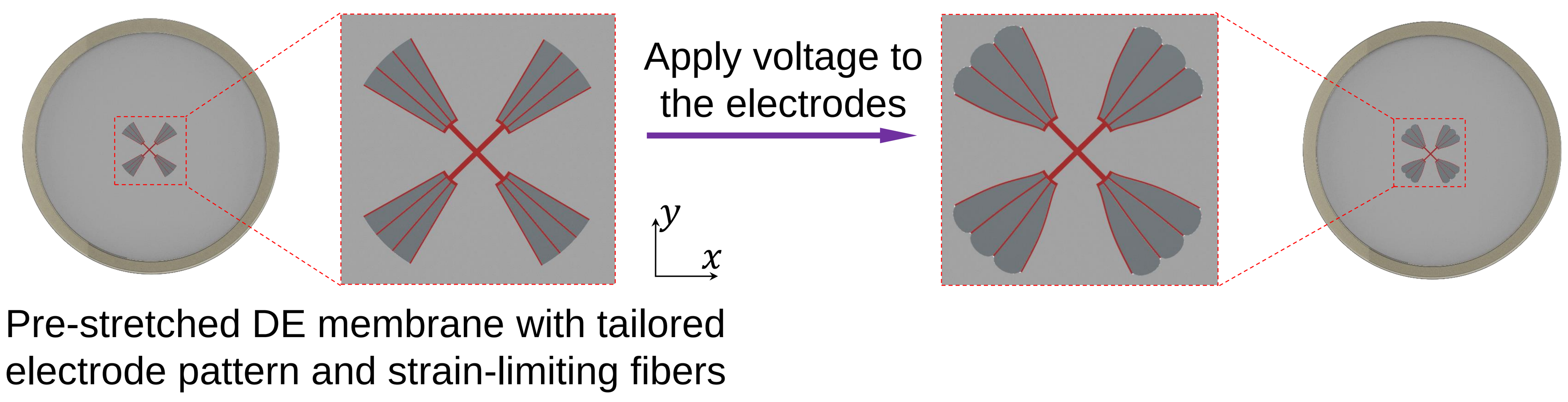
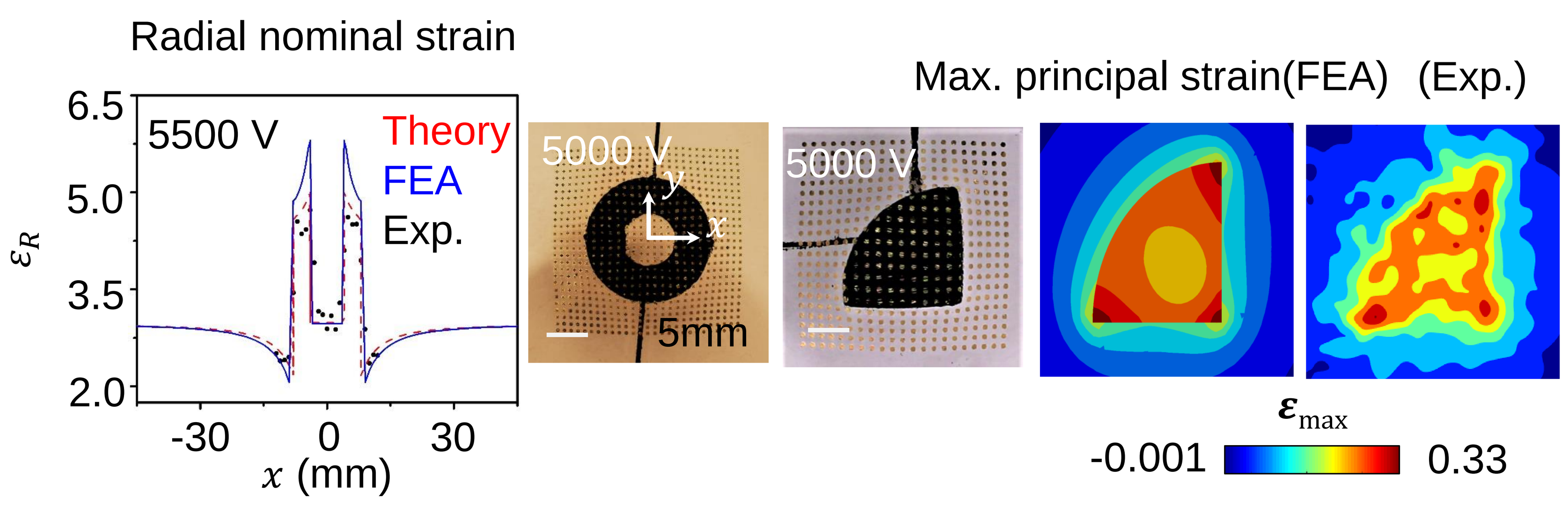


Figure 2 shows that strain-limited fibers can be integrated with DE membrane to induce anisotropic deformation. For example, if the directions of fibers are set along the radial direction, the actuation strain would be along the circumferential direction.

Results



In **Figure 3**, several types of DE platform with various patterns of electrodes (black area) are studied, and the in-plane strain distribution of these DE platforms can be accurately predicted by utilizing theory and finite element analysis which can be served as design tools.

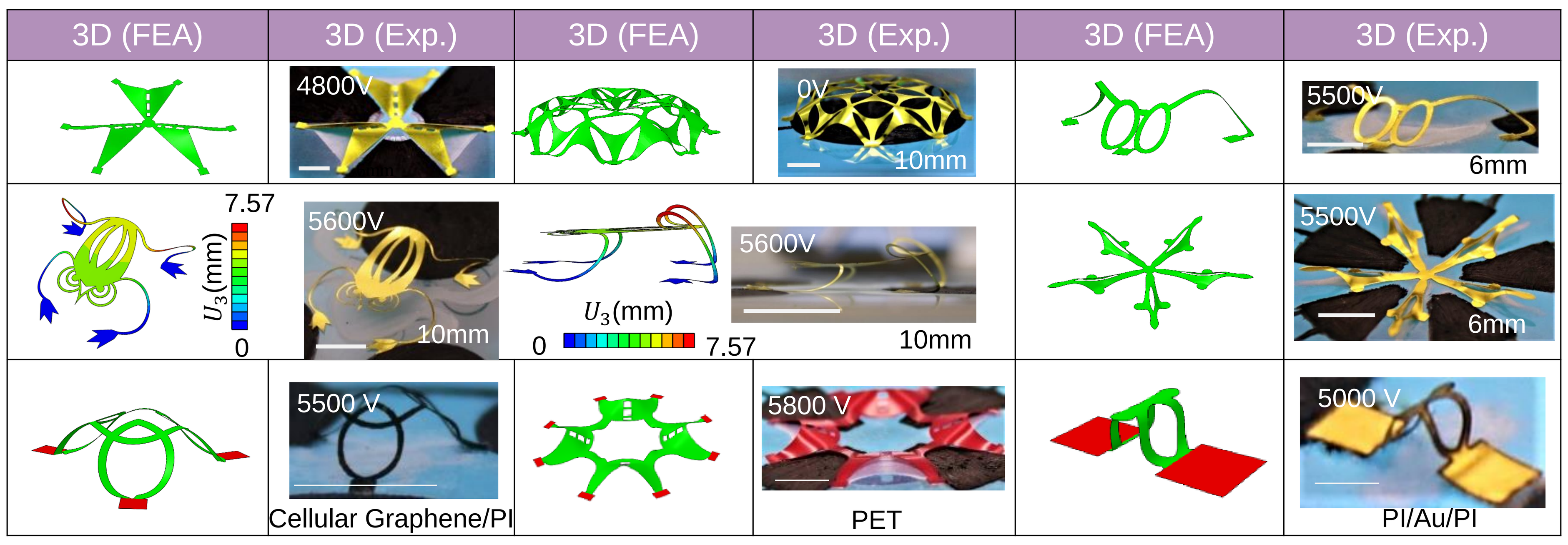


Figure 4 demonstrates FEA and experimental results of various 3D structures assembled by DE platform, in a broad set of materials (e.g., polymer, metal, graphene), with feature sizes ranging from millimeter scale to centimeter scale.

Figure 5 demonstrates a flexible 3D reconfigurable capacitor which is assembled by DE platform and can reshape into more than four different configurations. Such that, a *L-C* radial frequency circuit is fabricated with its resonant frequency tunable in a large range.

Conclusions

The concept by using the DEA as a platform for the mechanically guided assembly method, opens an access to a wide range of 3D mesostructures, all starting with 2D precursors that can be formed using the most sophisticated materials with large scales and methods in existing microsystems technologies.

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