An AgNW/graphene Hybrid Electrode for Durable Dielectric Elastomer Actuators

Haleh Shahsa
Phil Cuvin
Tobin Filleter
Mihai Duduta
University of Toronto, 5 King's College Rd, Toronto, Canada
Haleh.shahsa@mail.utoronto.ca

Dielectric elastomer actuators (DEAs) represent a promising class of soft actuators characterized by their lightweight, compliance, and suitability for a wide range of applications including actuation in soft robotics, haptic interfaces, and biomedical devices [1]. The DEA performance is directly linked to its stretchable electrodes' behaviour. Of the explored material systems for DEA electrodes, thin sheets of conductive nanomaterials such as silver nanowires (AgNWs) stand out as a promising option due to the exceptional electrical conductivity, high optical transparency, and robust mechanical strength. However, utilizing AgNW as a single conductive network limits the DEA performance due to its poor chemical and thermal stabilities [2]. In this study, we introduce a hybrid stretchable electrode consisting of AgNW network covered by a thin layer of graphene nano sheets to make durable and resilient DEAs. Our results confirm that adding an optimal concentration of graphene on top of AgNW networks, enhances the thermal stability and uniform heat distribution in the event of Joule heating. Consequently, the DEAs could stand higher voltages for longer time without compromising the resultant areal strain. We also developed a unique testing method to investigate the DEAs' electromechanical performance through cycles of charge and discharge. The results of this study open new horizons in design and fabrication of resilient and durable DEAs using 1 dimensional and 2 dimensional conductive nano materials.

References

[1] R. Pelrine, R. Kornbluh, Q. Pei, and J. Joseph, Science (1979).
[2] H. H. Khaligh et al, Nanotechnology (2017).

Figures

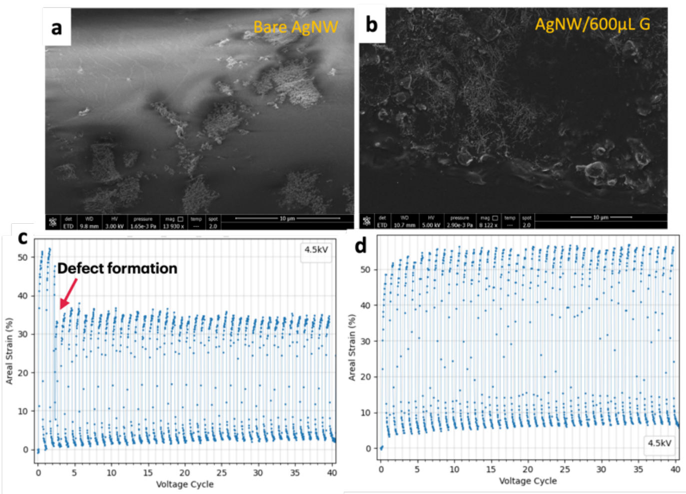

Figure 1: (a,b) scanning electron microscopy of the degradation in AgNW and AgNW/graphene electrodes, respectively. (c,d) DEA electromechanical performance of the DEAs with AgNW and AgNW/graphene electrodes, respectively.