Metallic Nanosheets-Based Electrochemical Actuator

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Technology description

Scanning electron microscope image of restacked 1T phase 2D MoS_2 film.b, The electrochemical system consists of a working electrode (the actuator) along with a counter electrode (Pt) and a reference electrode (standard calomel electrode, SCE) submerged in 0.5 M H_2SO_4.c, Images of curvature induced by charge intercalation in free-standing (that is, no Kapton beam) 1T MoS_2 film on gold (scale bar, 1 cm).d,e, Diagram (d) and photograph (e) of actuation in forward and backward directions by modulation of the electrode potential between -0.3 V and + 0.3 V.
Invention Summary:
Actuators that convert electrical energy to mechanical energy are useful in a wide variety of electromechanical systems and robotics. Nonporous metal as well as graphite have been implemented in actuation applications. Although high strains can be achieved, but actuation only operates at high voltages (3-3.4 V) and very low frequencies (mHz range).
Researchers at Rutgers University have invented a novel macroscopic actuation device made of (2D) 1T phase molybdenum disulfide (MoS_2) nanosheets-coated flexible films that can operate at low voltages (+0.3 to –0.3 V) and frequencies up to 1 Hz. The mechanism of actuation is the insertion and removal of cations between nanosheets of (2D) 1T phase MoS_2 under electrochemical induction of +0.3 to –0.3V. The MoS_2 films are able to generate mechanical stresses of ~ 17 MPa – higher than mammalian muscle (~0.3 MPa) and comparable to ceramic piezoelectric actuators (~ 40 MPa). The actuation performance is attributed to the high electrical conductivity of the metallic 1T phase of MoS_2 nanosheets, the elastic modulus of restacked MoS_2 layers and fast proton diffusion between the nanosheets.
Publication:
Metallic molybdenum disulfide nanosheet-based electrochemical actuators. Acerce M, Akdoğan EK and Chhowalla M. (2017)Nature549: 370-373.

Application area

Electromechanical systems and robotics such as steerable catheters for biomedical applications, adaptive wings for aircrafts, or drag-reducing wind turbines.

Advantages

High displacement
High generated force
Low potential
High frequency (1 Hz)

Institution

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