Light-actived Rapid Response of Lead Halide Perovskites for Flexible Multi-functional Actuator/Transistor Devices

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Abstract

Organic-inorganic hybrid perovskite materials (OIHPs) perform outstanding optoelectronic properties, extending their extraordinary usage in photovoltaics, photodetectors and light-emitting diodes. However, the mechanical behavior, which is of great importance to the stability of perovskite-based devices, have rarely been explored. Here, based on the methylammonium lead triiodide ($MAPbI_3$) and graphene oxide (GO) composite bilayer film, a flexible actuator was designed with remarkable light-induced actuation performances including ultralarge deformation (rotation angel change >400°) and fast response (<1 s). From in situ variable temperature X-ray diffraction, fluorescence spectrum, numerical simulations and a series of control experiments, the actuating mechanism for macroscopic deformation was elucidated as reversed lattice expansion/contraction of perovskite and GO films triggered by light irradiation. Additionally, logical transistor array could be easily integrated onto this micro-mechanical systems considering the exclusive optoelectronic properties of perovskite. A new way is ushered through this functional flexible actuator with logical transistor array to realize programmable actuation, which is expected to be of paramount importance for soft robots and devices toward practical applications.

References

[1] Zhao, J.J.; Deng, Y.H.; Wei, H.T.; Zheng, X.P.; Yu, Z.H.; Shao, Y.C.; Shield, J.E.; Huang, J.S.: Strained hybrid perovskite thin films and their impact on the intrinsic stability of perovskite solar cells. Science Advance, Vol. 3, No. 11, eaao5616, 2017.

[2] Chen, B.; Li, T.; Dong, Q.F.; Mosconi, E.; Song, J.F.; Chen, Z.L.; Deng, Y.H.; Liu, Y.; Ducharme, S.; Gruverman, A.; Angelis, F.D.; Huang, J.S.: Large electrostrictive response in lead halide perovskites. Nature Materials, Vol. 17, No. 11, pp. 1020, 2018.

[3] Li, K.R.; Shao, Y.L.; Yan, H.P.; Lu, Z.; Griffith, K.J.; Yan, J.H.; Wang, G.; Fan, H.W.; Lu, J.Y.; Huang, W.; Bao, B.; Liu, X.L.; Hou, C.Y.; Zhang, Q.H.; Li, Y.G.; Yu, J.S.; Wang, H.Z. Nature Communications. Vol. 9, 4798, 2018.