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Photo-driven Molecular Dipole Reordering in Metalorganic Halide Perovskites

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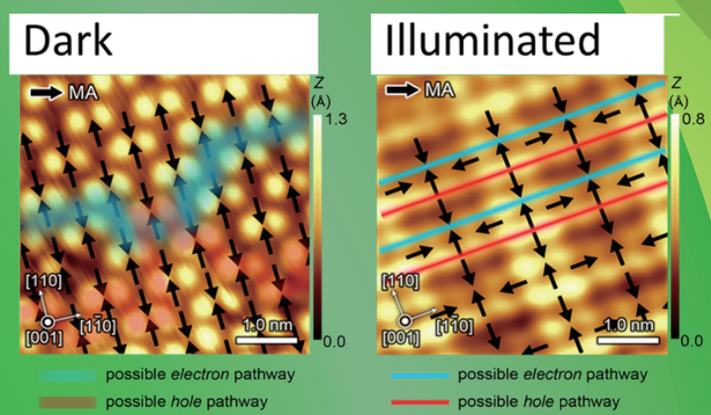
Organometal halide perovskites enabled an explosive improvement of the efficiency of solar cells. Theoretical calculations suggest that the orientation of the organic molecules' dipole may affect the electronic structure. However, thus far no real space experimental mapping of the molecule orientation *and* potential has been reported. Here, we map *simultaneously* the molecule dipole orientation pattern *and* the electrostatic potential with atomic resolution and under laser illumination using scanning tunneling microscopy and spectroscopy. We observe a light-induced transition of the molecule orientation order creating one-dimensional potential wells, which enable electron-hole separation. We anticipate that light-induced polarization order transition could be at the origin of the extraordinary efficiencies of organometal halide perovskite-based solar cells.



[1] Hung-Chang Hsu, Bo-Chao Huang, Shu-Cheng Chin, Cheng-Rong Hsing, Duc-Long Nguyen, Michael Schnedler, Raman Sankar, Rafal E. Dunin-Borkowski, Ching-Ming Wei, Chun-Wei Chen, Philipp Ebert, and Ya-Ping Chiu, "Photo-Driven Dipole Reordering: Key to Carrier Separation in High Efficiency Halide Perovskite Solar Cells", (*ACS Nano*, in publication, 2019).

[2] M. D. Siao, W.C. Shen, R.S. Chen, Z.W. Chang, M.C. Shih, Y.P. Chiu & C.-M. Cheng, Two-dimensional electronic transport and surface electron accumulation in MoS2, *Nature Communications 9, 1442 (2018).*

[3] Bo-Chao Huang, Pu Yu, Y. H. Chu, Chia-Seng Chang, Ramamoorthy Ramesh, Rafal E. Dunin-Borkowski, Philipp Ebert, and Ya-Ping Chiu. "Atomically Resolved Electronic States and Correlated Magnetic Order at Termination Engineered Complex Oxide Heterointerfaces". *ACS Nano, 12 (2), 1089 (2018).*

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