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Wrinkles and Folds as Photonic Structures in Polymer Photovoltaics YUEH-LIN LOO, JONG BOK KIM, Chemical and Biological Engineering, PILNAM KIM, HOWARD STONE, Mechanical and Aerospace Engineering, NICOLAS PEGARD, JASON FLEISCHER, Electrical Engineering, Princeton University, SOONG JU OH, CHERIE KAGAN, Materials Science and Engineering, University of Pennsylvania — We exploit the elastic instabilities of polymer surfaces under compressive mechanical stress to generate wrinkles and deep folds with prescribed dimensions and at pre-specified coverage over large areas. These wrinkles and deep folds act as photonic structures; they increase light coupling into and trapping within polymer photovoltaics. Devices on these surfaces show a 79% increase in the external quantum efficiency (EQE) in the visible compared to analogous devices on flat surfaces. More significantly, we observe an exponential increase in near-infrared light absorption in these devices. In both experiments and numerical simulations, we find that these structures extend the useful range of energy conversion by >200 nm, corresponding to a 600% increase in the EQE in the near-infrared where light is otherwise minimally absorbed. While we demonstrate this concept with polymer photovoltaics, the controlled introduction of compressive stress provides a straightforward and economical route to large-scale patterning of photonic structures for flexible opto-electronics.

Yueh-Lin Loo
Princeton University

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