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The Plasmoelectric Effect: Optical Control of the Electrochemical State of Plasmonic Absorbers MATTHEW SHELDON, ANA BROWN, HARRY ATWATER, California Institute of Technology — The plasmonic properties of metallic nanostructures depend strongly on charge carrier density. While researchers have reported shifts of the resonant absorption frequency of plasmonic nanostructures due to electrostatically induced changes of charge density, the converse —the dependence of charge density and electrostatic potential on optical absorption—has been largely overlooked. Here, we report a theoretical framework and provide experimental evidence for a 'plasmoelectric effect', an optically induced electrochemical potential in plasmonic nanostructures. Our thermodynamic model shows that, unlike the more familiar thermoelectric or photovoltaic effects, the magnitude and sign of the plasmoelectric potential depends on the frequency difference between the plasmon resonance and incident radiation. Radiation at higher frequencies induces an increase of electron density in the nanostructure that blue-shifts the plasmon resonance. This response is favored due to increased entropy from increased absorption. Similarly, radiation at lower frequencies decreases electron density. Systematic electrical and optical studies of plasmonic Au nanostructures display clear evidence for the structure-dependent and wavelength-dependent trends consistent with our theoretical framework.

Matthew Sheldon
California Institute of Technology

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