Increasing Energy Harvesting Capabilities in Organic Photovoltaic Cells

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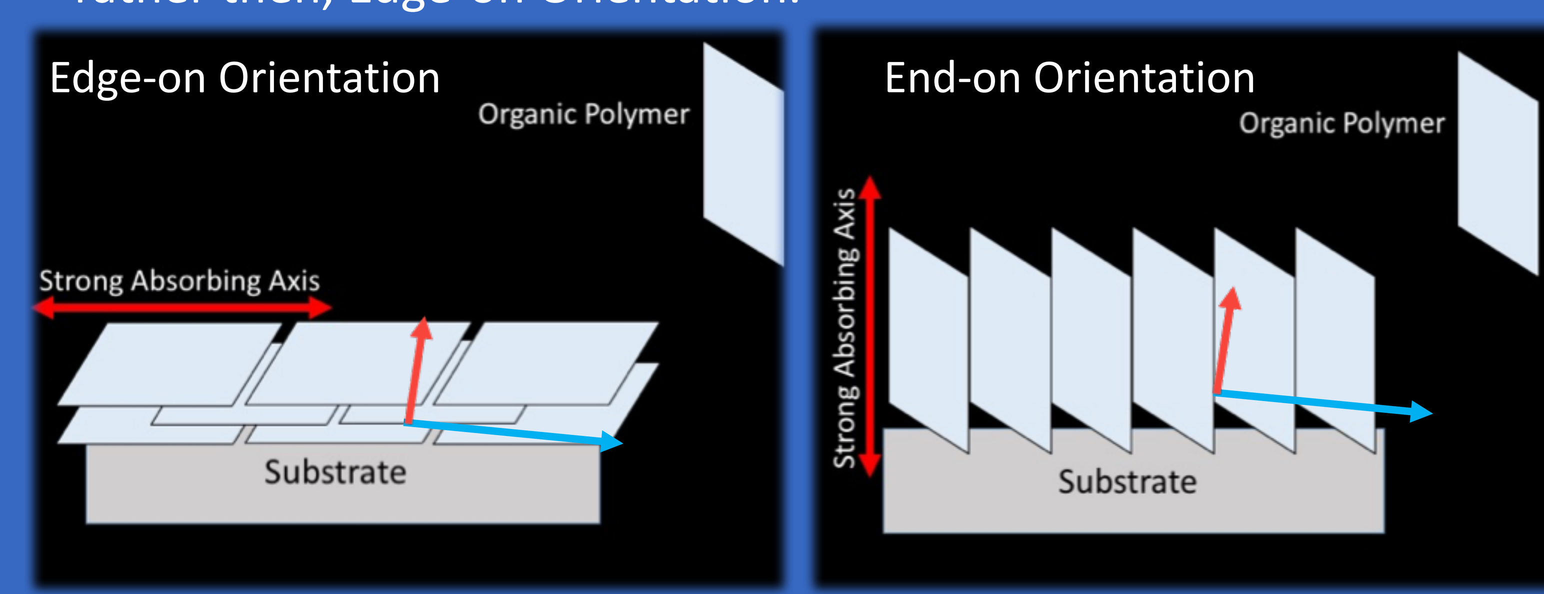
Why Organic Solar Cells?

Solar energy is a viable solution to the dwindling supply of fossil fuels and global warming. However, there are two types of solar cells —organic and inorganic. Organic solar cells are made from carbon-based materials, while inorganic are from silicon or other semi-conducting materials. Organic photovoltaic cells -- being lightweight, durable, flexible, and cost-efficient -- present novel opportunities for optoelectronic devices, wearables, and other technologies. Though they lag behind inorganics, organic solar cells are a true clean source of energy. They're constructed from mass-produced materials, manufactured in a continuous printing method, and cost and energy efficient in production. Inorganics, though more efficient, are expensive, complex, and use harmful chemicals and materials.

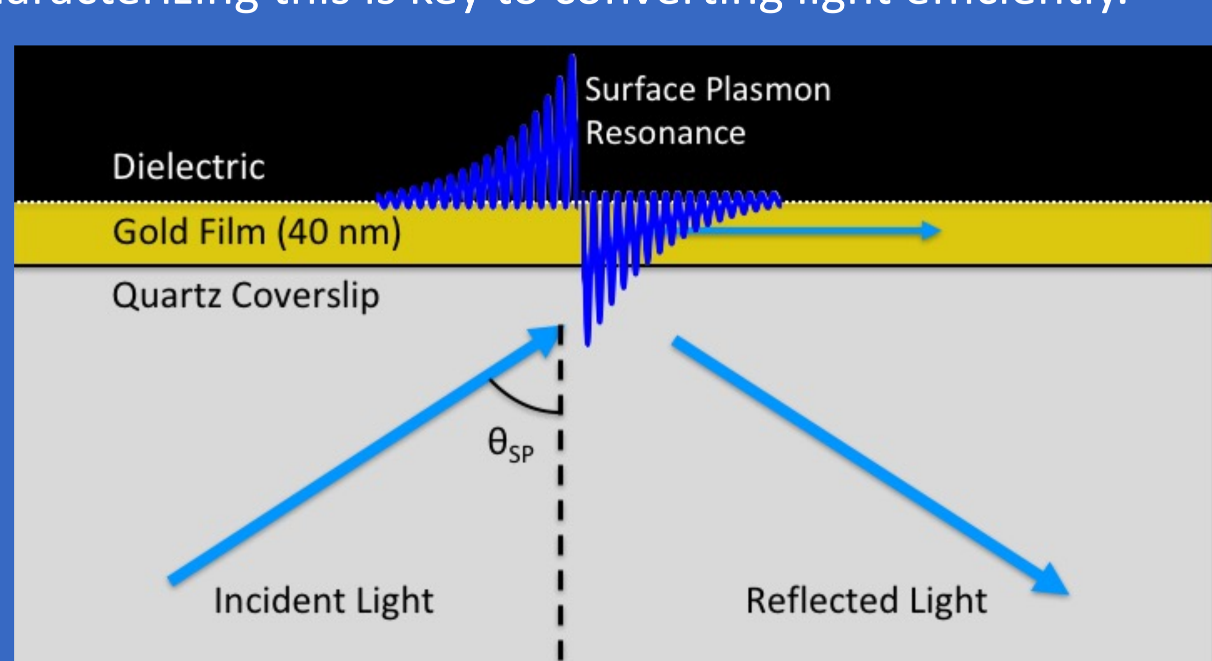
Orientation Efficiency

Many organic polymers form optically anisotropic (directional dependent) orientations. Depending on how the material is applied, different orientations can result. The Schuller Group theorizes that, by optimizing the orientation of an organic polymer, we can enhance energy harvesting efficiency. As seen in the figures below, the electric field (red arrow) of the light ray (blue arrow) aligns clearly with the strong absorbing axis in End-on Orientation rather then, Edge-on Orientation.



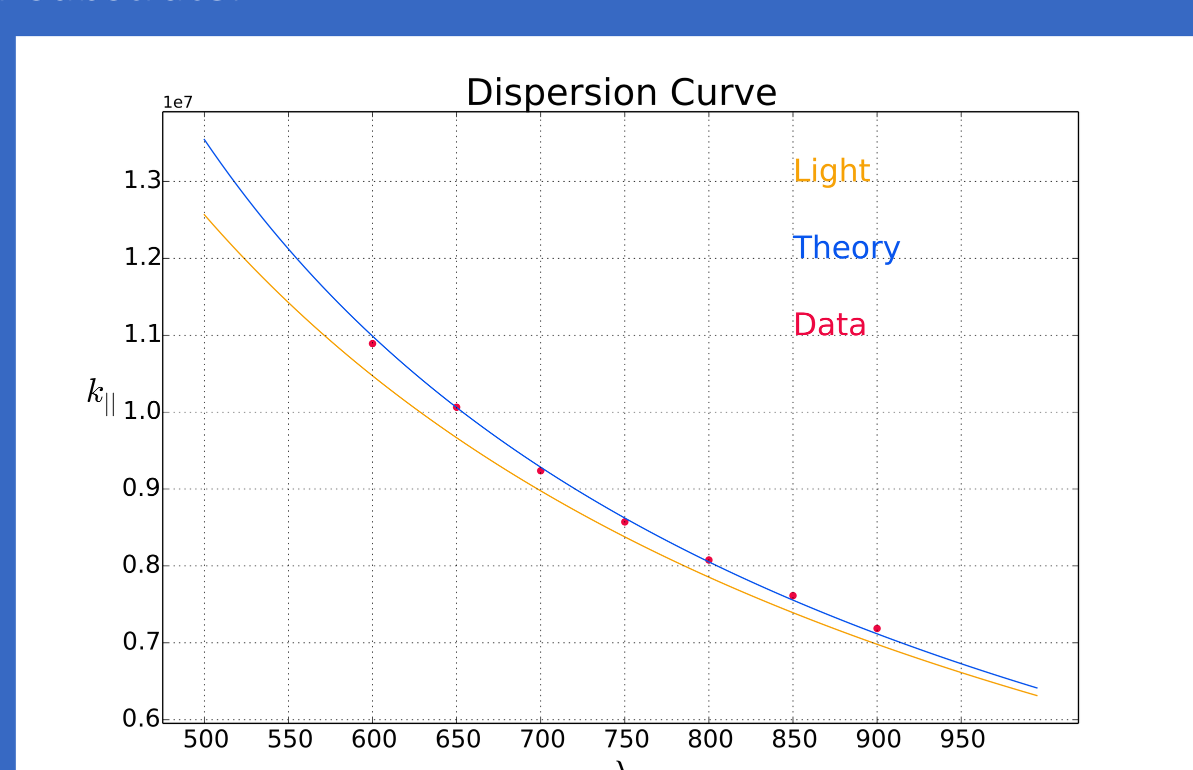
Experiment

To understand how light interacts with our substrate — a gold film on quartz coverslip — we used Momentum-Resolved Spectroscopy, which allows us to change the angle of incident light on the sample and measure the reflected light. Light bends at a material interface and this light excites oscillations in the charges of the gold film. Matching the natural oscillations of the charges excites a phenomenon called Surface Plasmon Resonance. This resonance corresponds to a drop in reflection, or spike in absorption. Characterizing this is key to converting light efficiently.



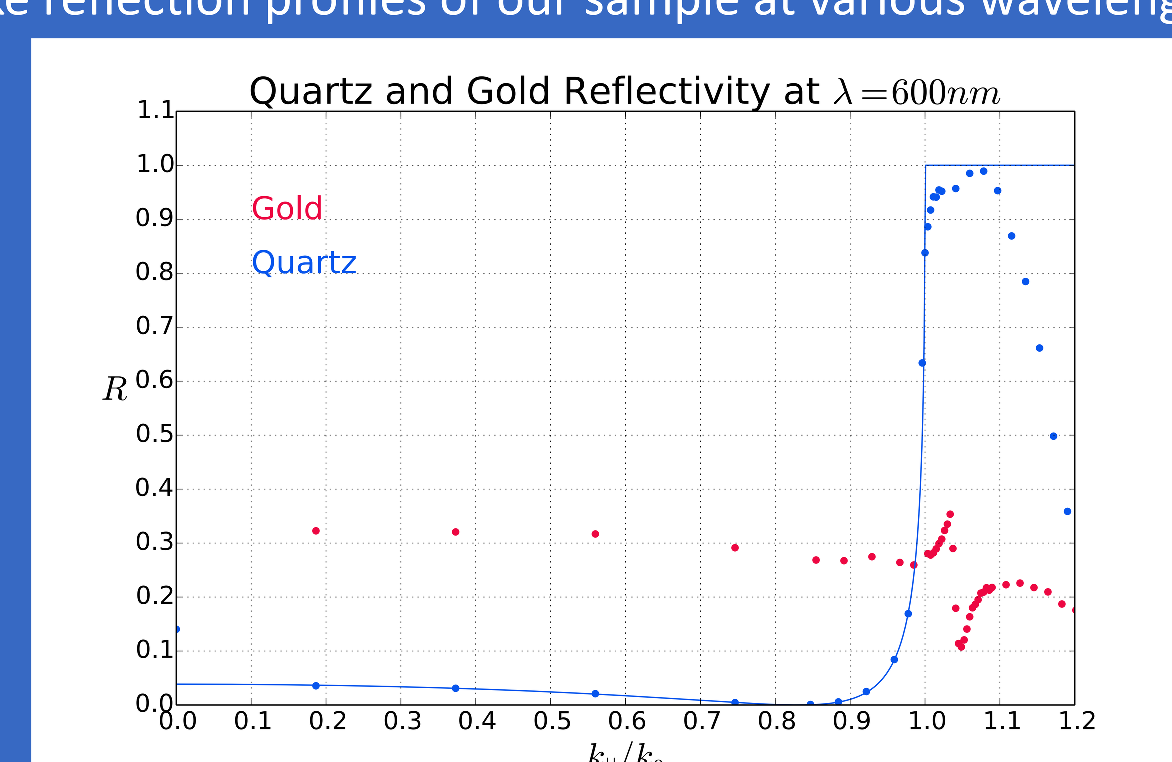
Plasmon Dispersion Relation

Taking the fitted location of the plasmon location for multiple wavelengths, we can plot a plasmon dispersion relation governing the location of maximum absorption in our substrate.

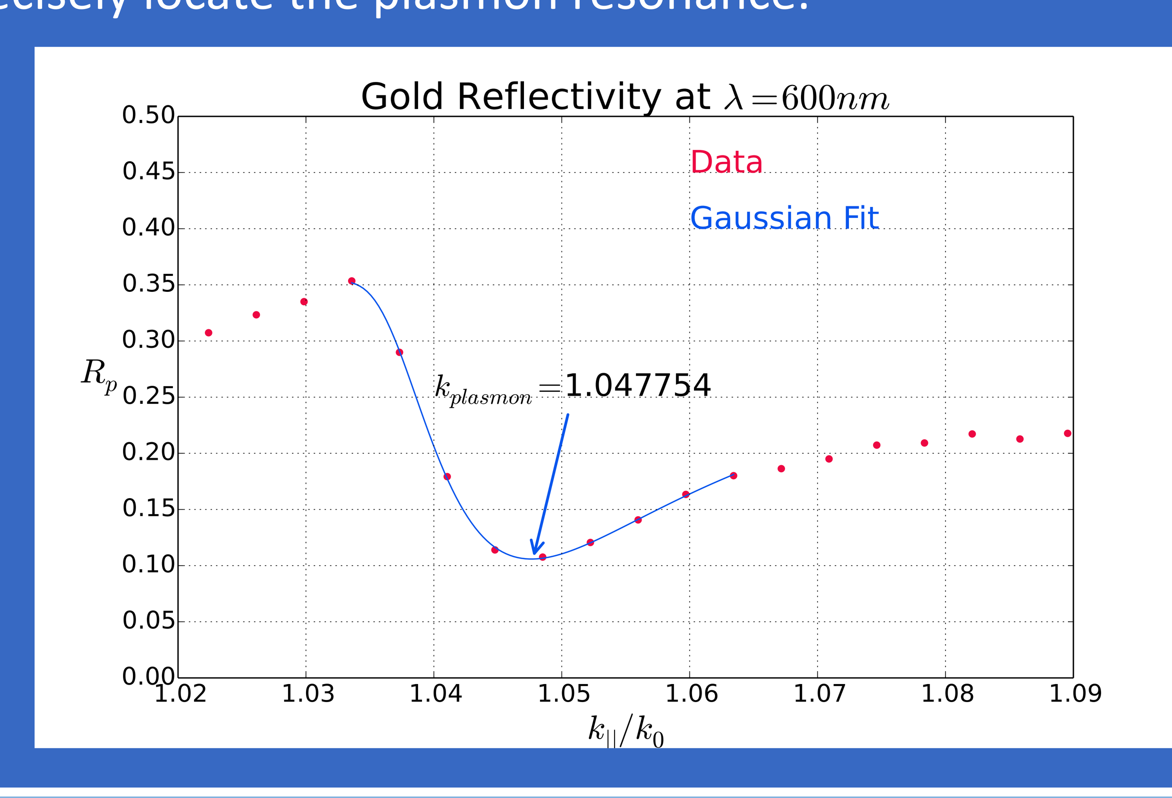


Data

Using Momentum-Resolved Spectroscopy, we are able to take reflection profiles of our sample at various wavelengths.



Then, we fit the gold profile with a modified Gaussian to precisely locate the plasmon resonance.



Characterizing Organics

In the upcoming weeks, we aim to begin characterizing organic polymer orientations and demonstrate this as a viable approach to increasing OPV efficiency.

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