International Institute for Carbon-Neutral Energy Research

Opto-Ionics – Dynamic Investigation of the Mechanism behind the Increased Ionic Conductivity under Light Illumination

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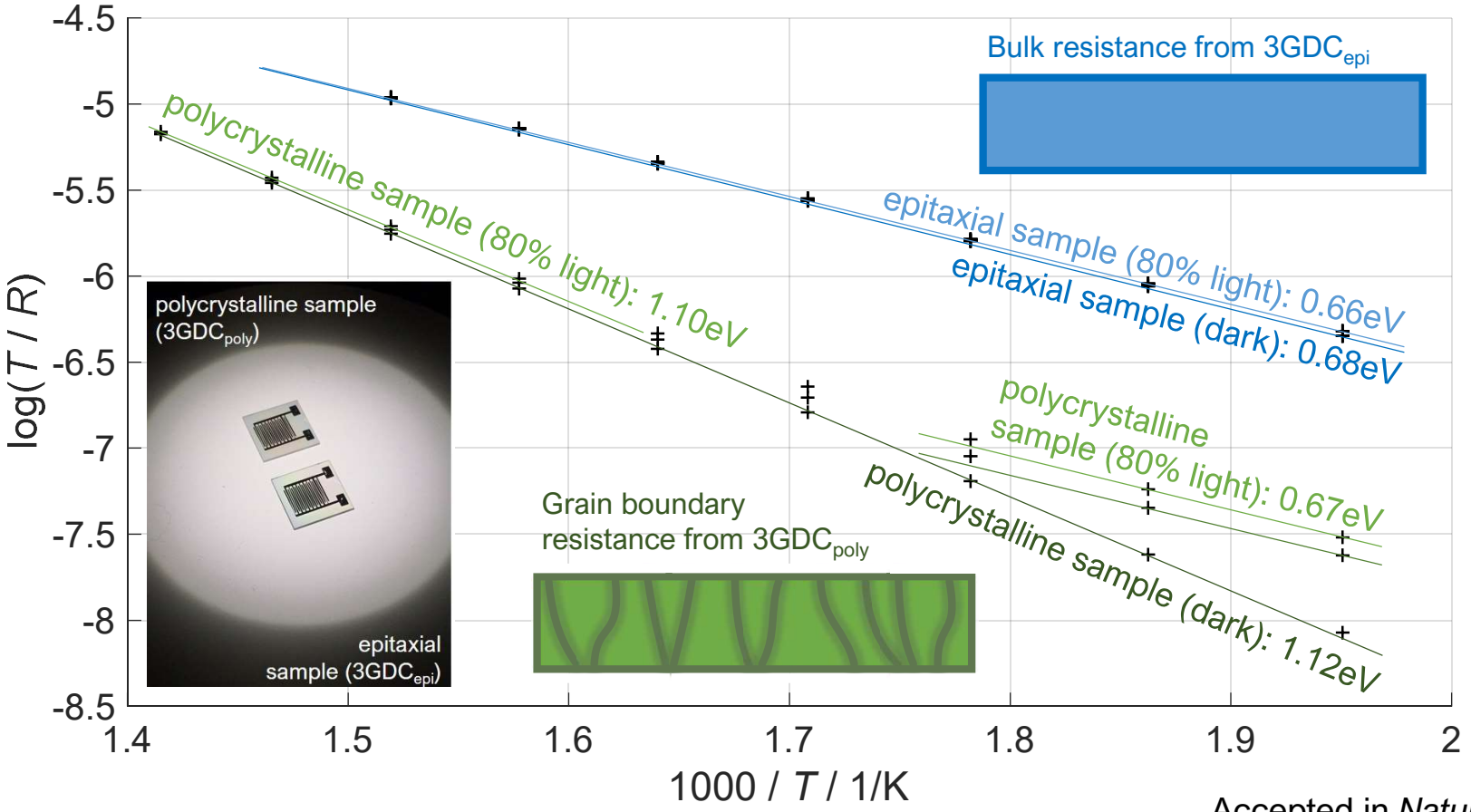
Recent Results:
Increased Ionic Conductivity under UV Illumination



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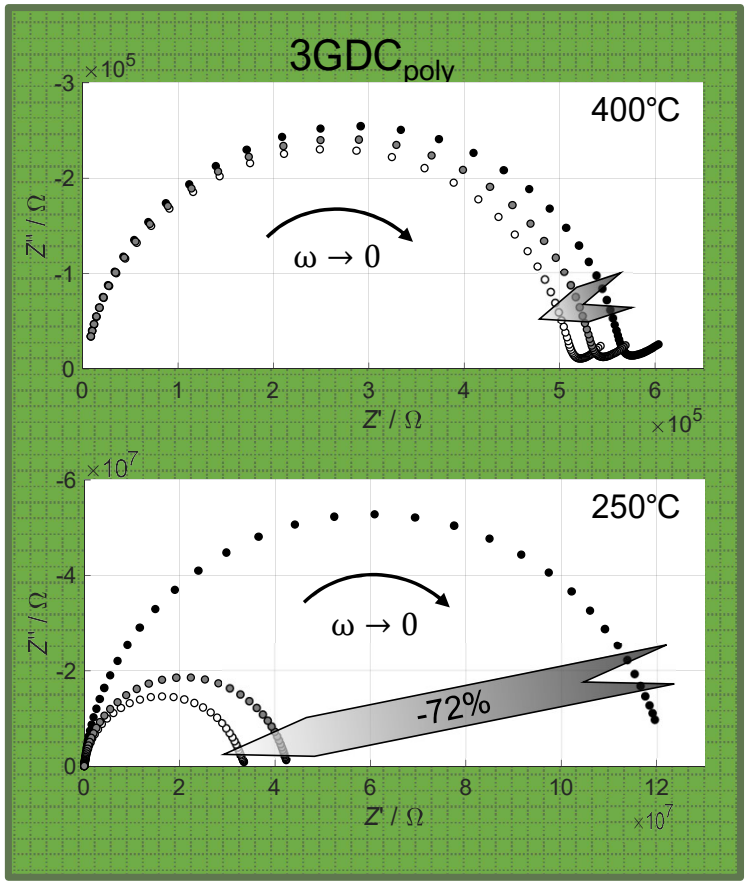
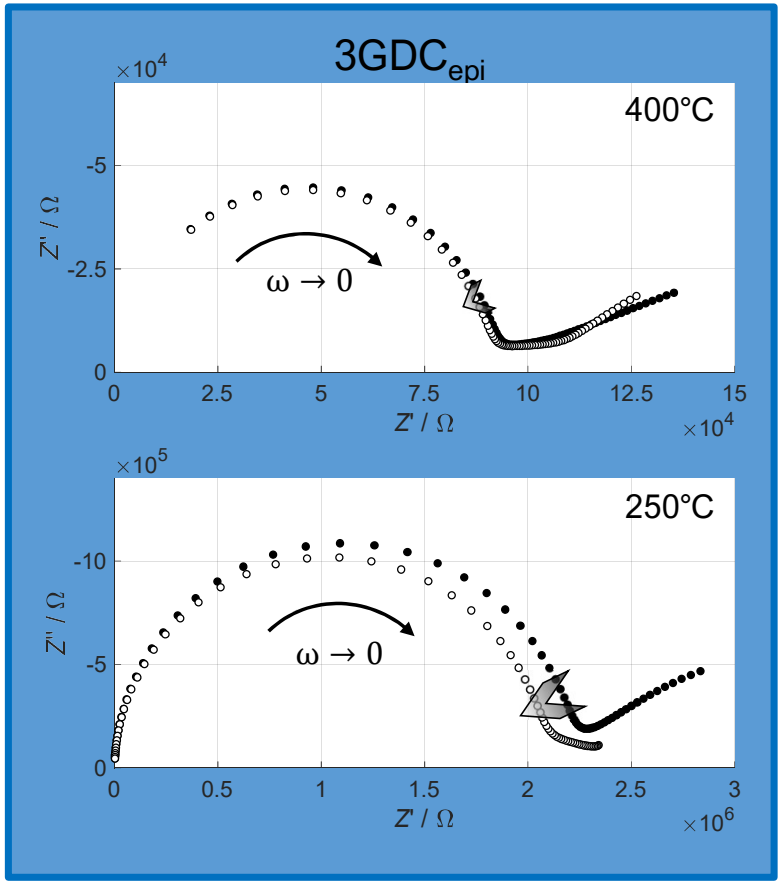
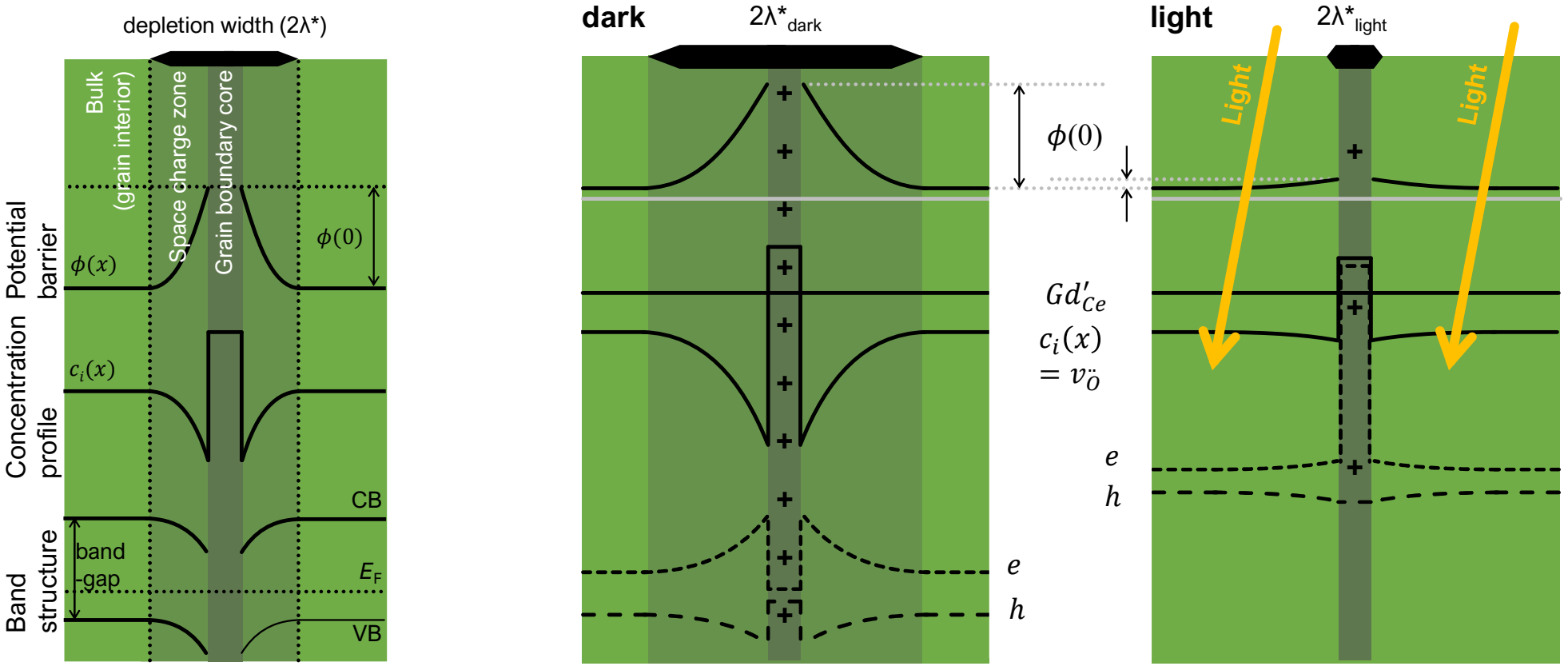
Impedance Spectroscopy Results (dark/light)

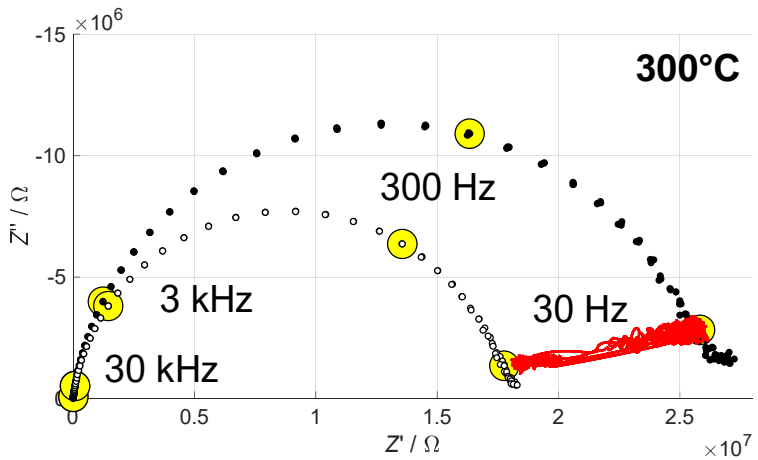


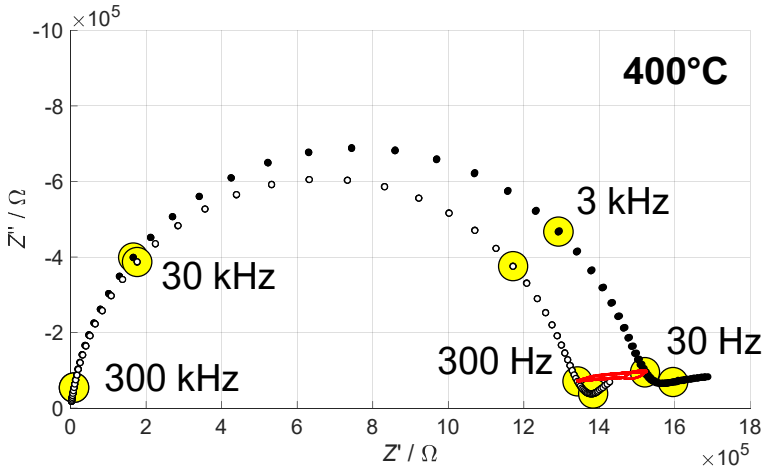


Modelling Background



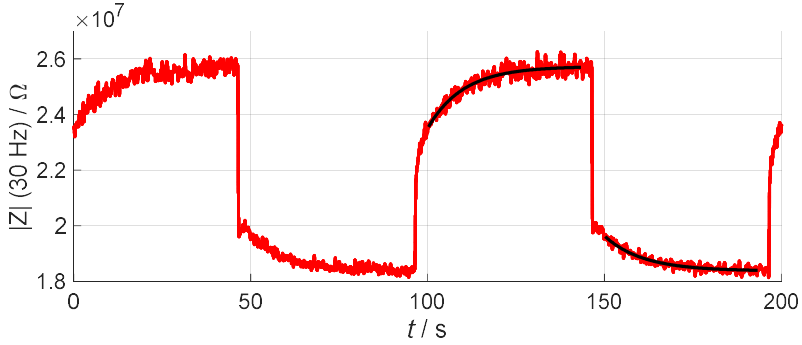
Single-Frequency Impedance Transients

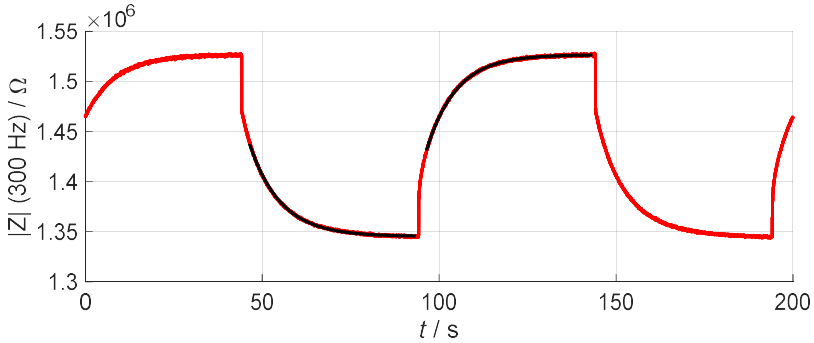




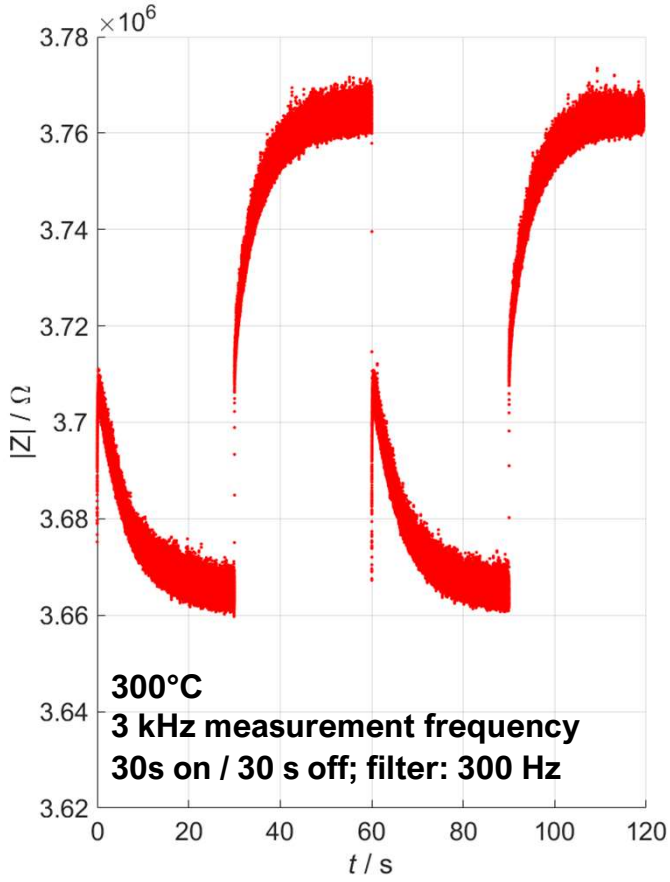
Single-Frequency Electrochemical Impedance Spectroscopy

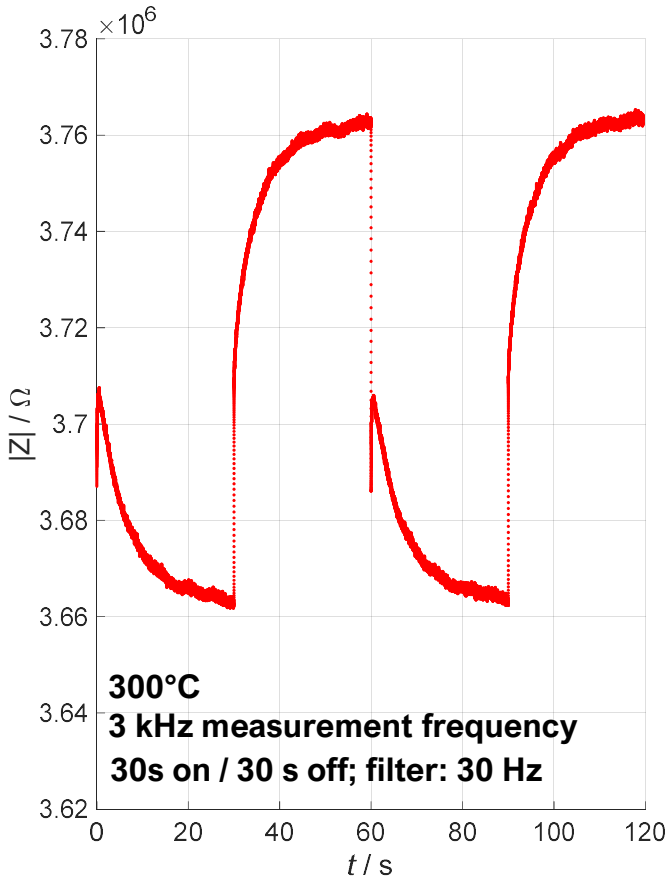
Continuously measuring one single frequency over time while switching the light on and off (measured by Zurich Instruments MFIA)



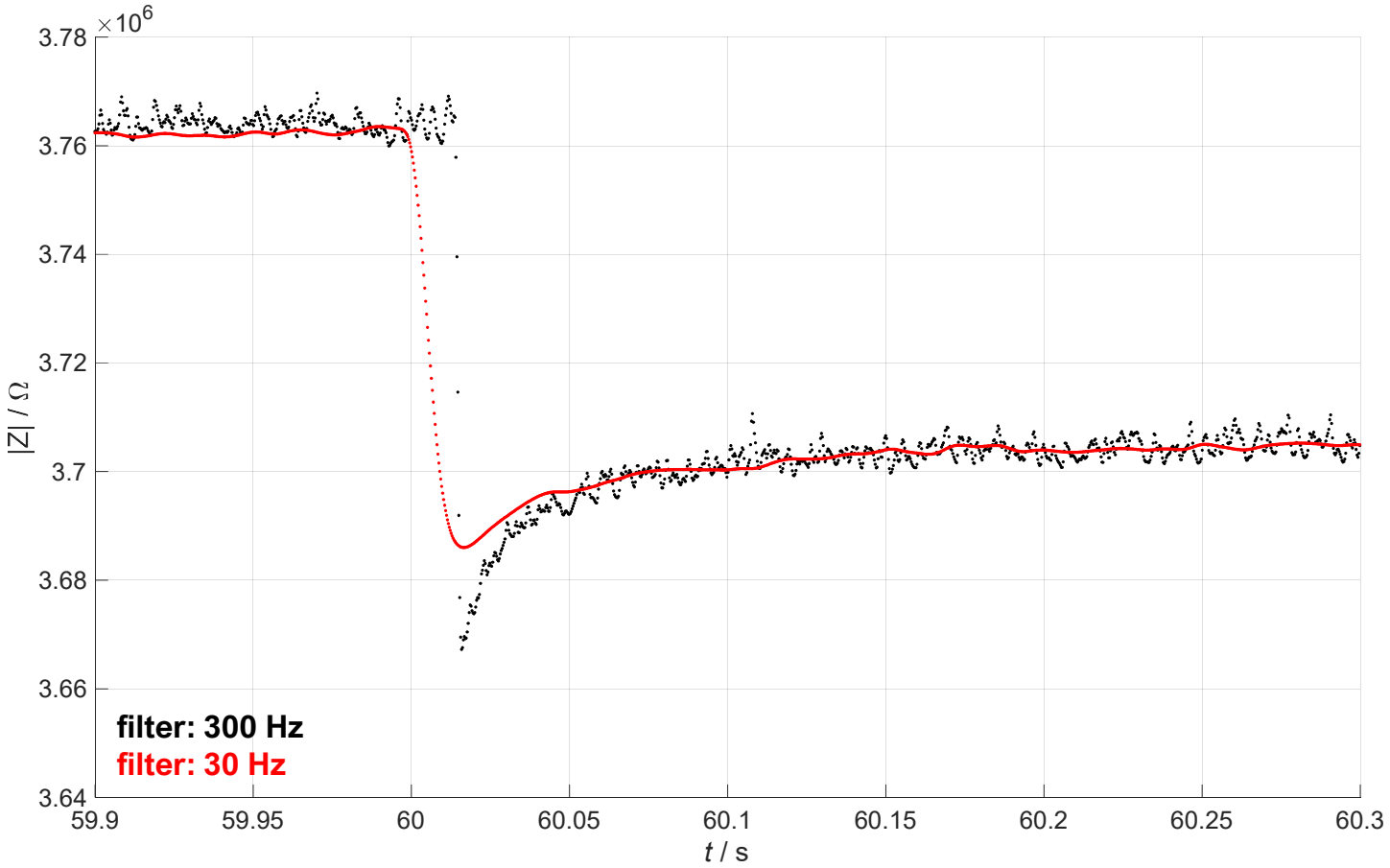


Single-Frequency Impedance Transients





Single-Frequency Impedance Transients



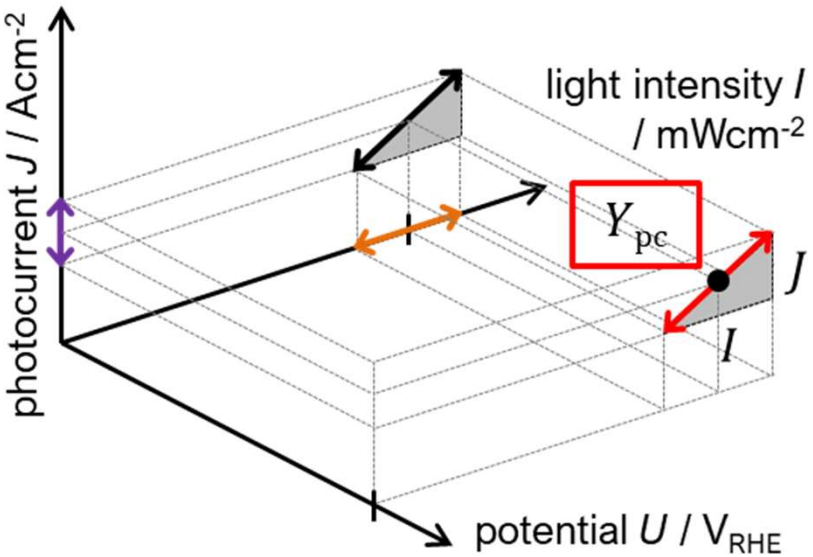
IMPS – Photoelectrochemical Impedance

IMPS: intensity-modulated photocurrent spectroscopy

$$Y_{pc}(\omega) = \frac{J(\omega)}{I(\omega)}$$

photocurrent admittance

- result is a spectrum for a wide range of frequencies, mainly limited be the light source
- well-established in the field of photoelectrochemistry
- usually for “photoactive” devices



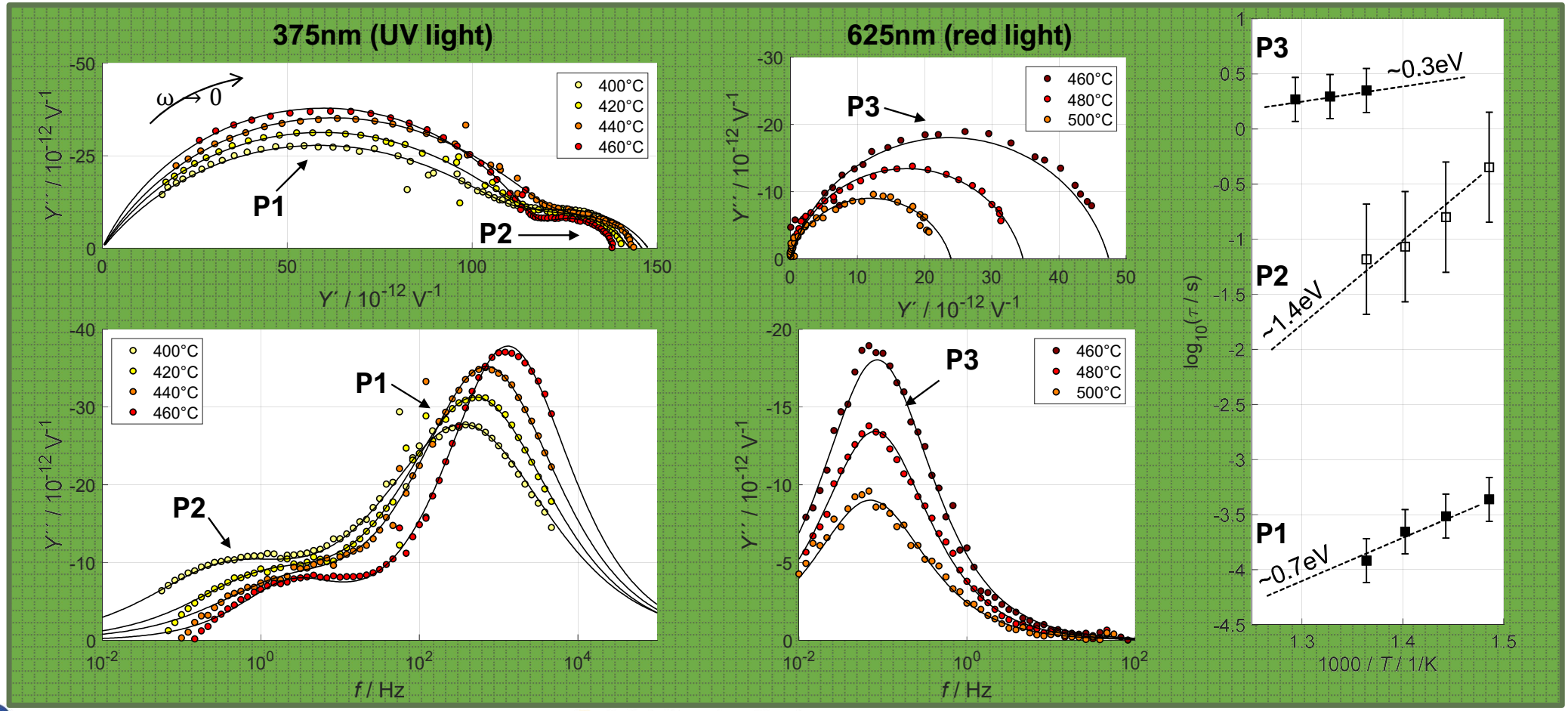
Advantages

- higher frequencies possible
- operating point can be chosen
- small-signal perturbation
- different process can be distinguished easily

Disadvantages

- bias voltage required
- currents might be very small (oscillating current as response to light even smaller)
- no on/off cycles (no triggering of specific events)

IMPS – Results



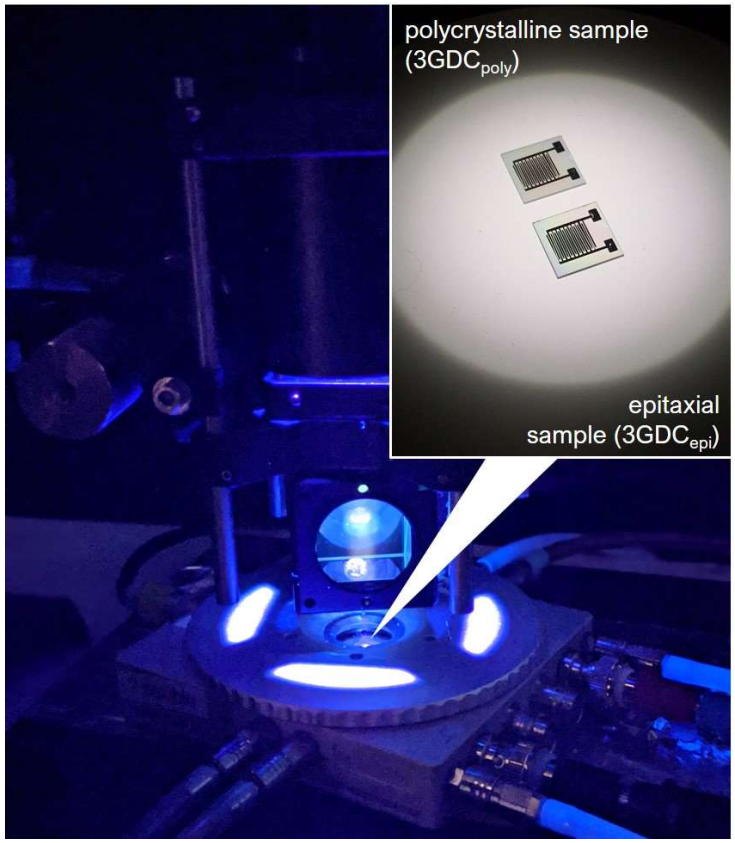
Summary

New “opto-ionic” effect was discovered!

- **Dynamics used to identify the fundamental processes;**
- **different techniques come with different advantages and disadvantages;**
- **combining those techniques can help to identify photoelectrochemical processes.**

Ongoing work:

- **Clarify the fundamental processes;**
- **control the opto-ionic effect efficiently;**
- **design better materials with higher ionic conductivity.**



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