

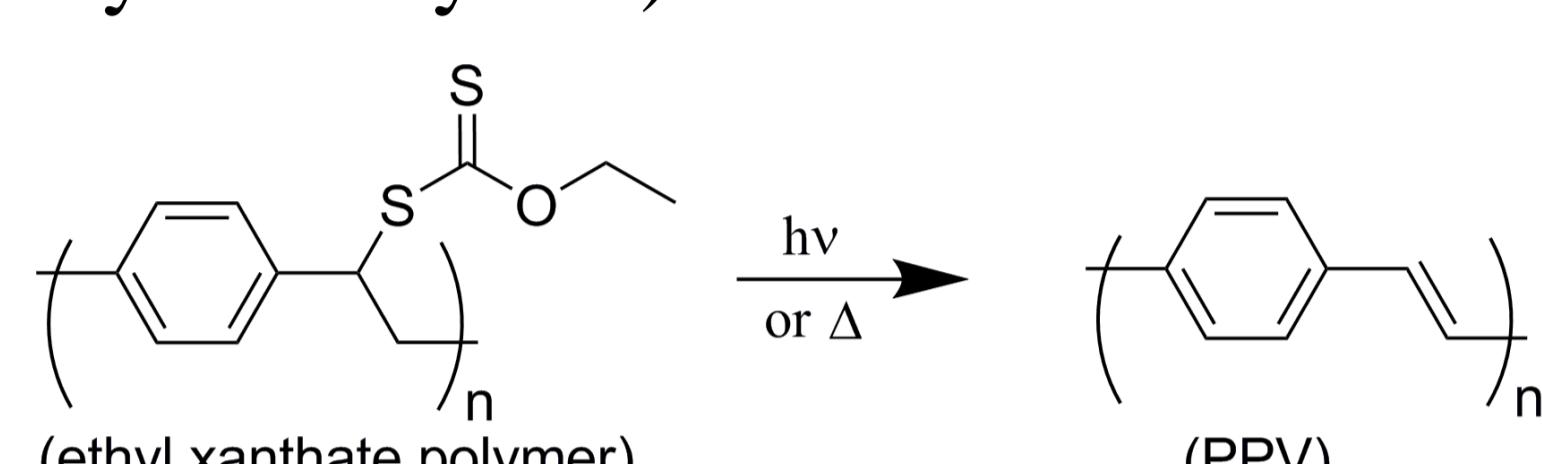
# Photo-lithography of Xanthate Precursor Poly(*p*-phenylenevinylene) Polymers

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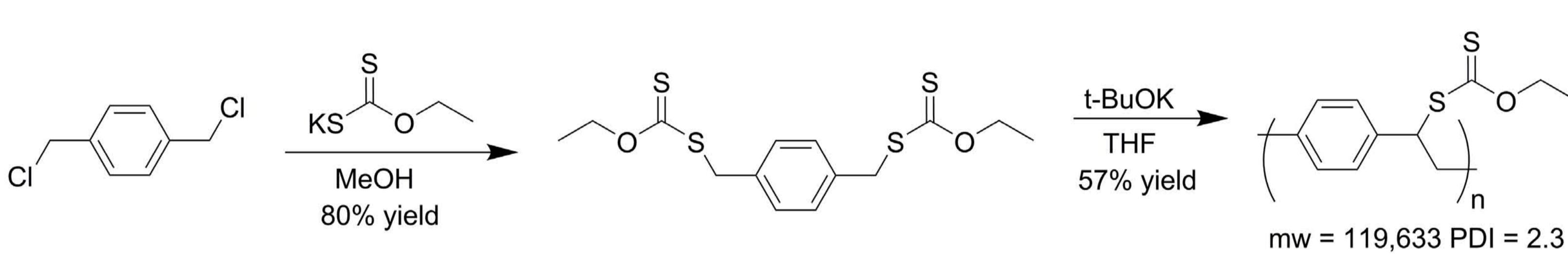
## Introduction

Conjugated polymers such as poly(*p*-phenylenevinylene) (PPV) have attracted a great deal of attention due to their electronic and optoelectronic properties. The ability to control the lateral spatial resolution of conjugated polymers will allow for improved integration into electronic devices. We present a method for photopatterning a xanthate precursor polymer leading to micron scale spatial control of conjugated poly(*p*-phenylenevinylene).



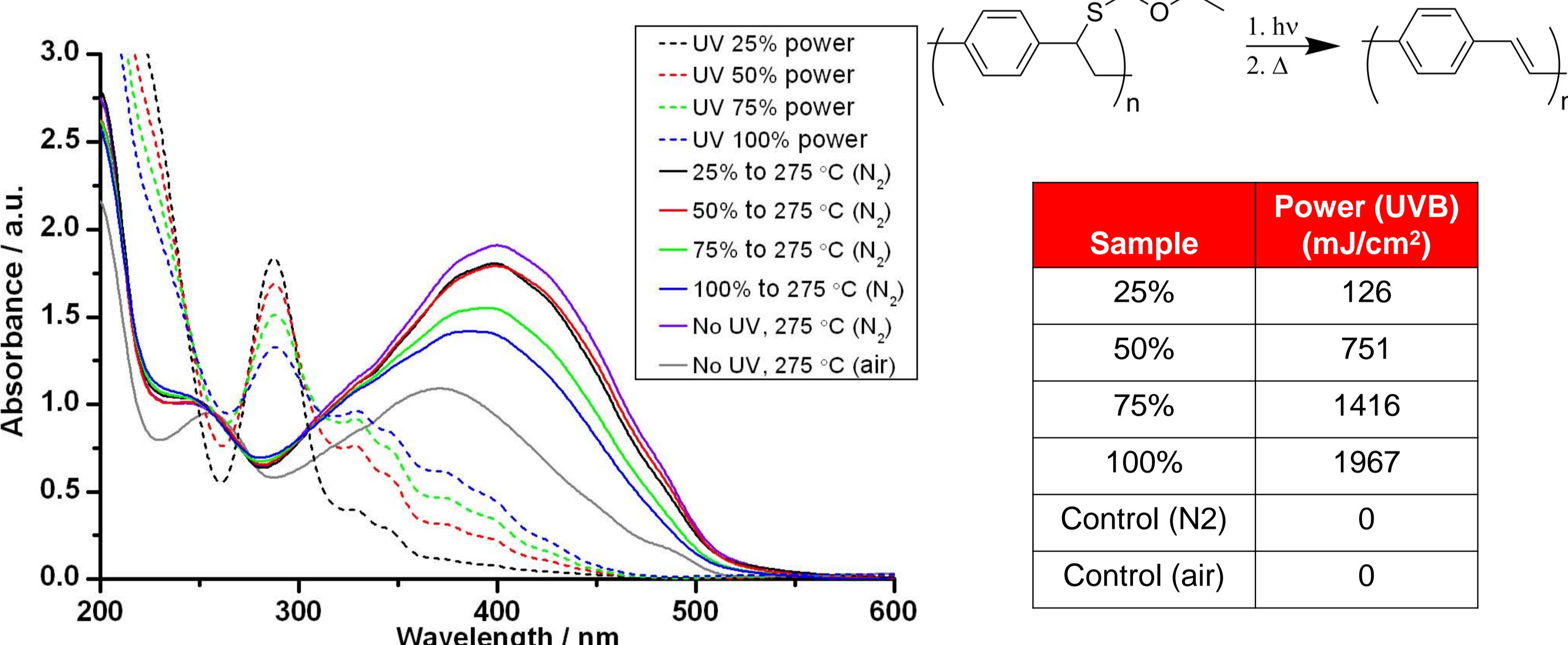
## Synthesis

The xanthate precursor polymer was synthesized in two steps with good yields.



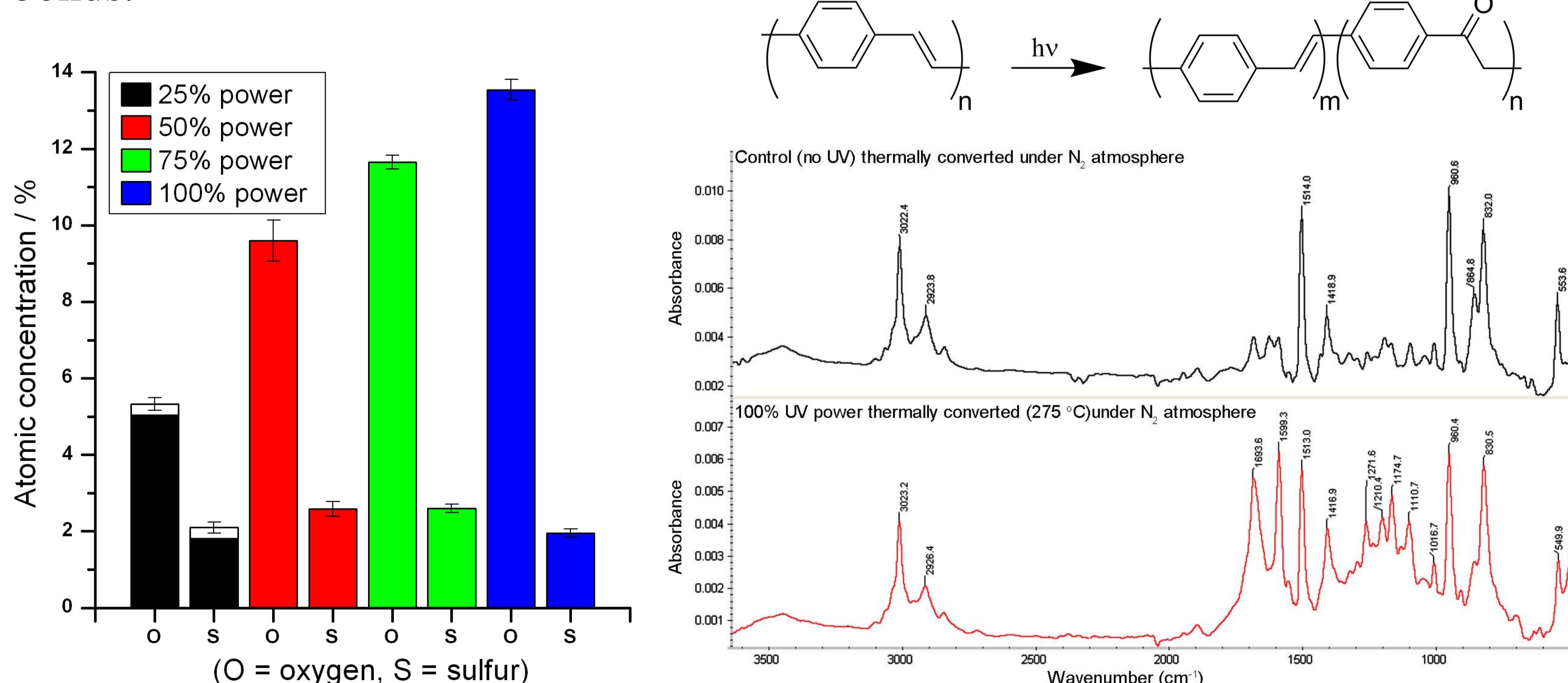
## Light Exposure vs. UV-Vis

A light exposure study was performed to determine the optimal dosage to the xanthate precursor polymer. A solution of the polymer (2.5% w/w in CHCl<sub>3</sub>) was spin-coated onto 1x1 inch quartz slides. The samples were exposed to varying intensity UV light using a Fusion UV System (the power levels were quantified using a radiometer). High exposure levels reduced conjugation lengths (after thermal treatment). Lower exposure levels caused slight hypochromic effects, but did not reduce conjugation lengths.



## XPS and FTIR

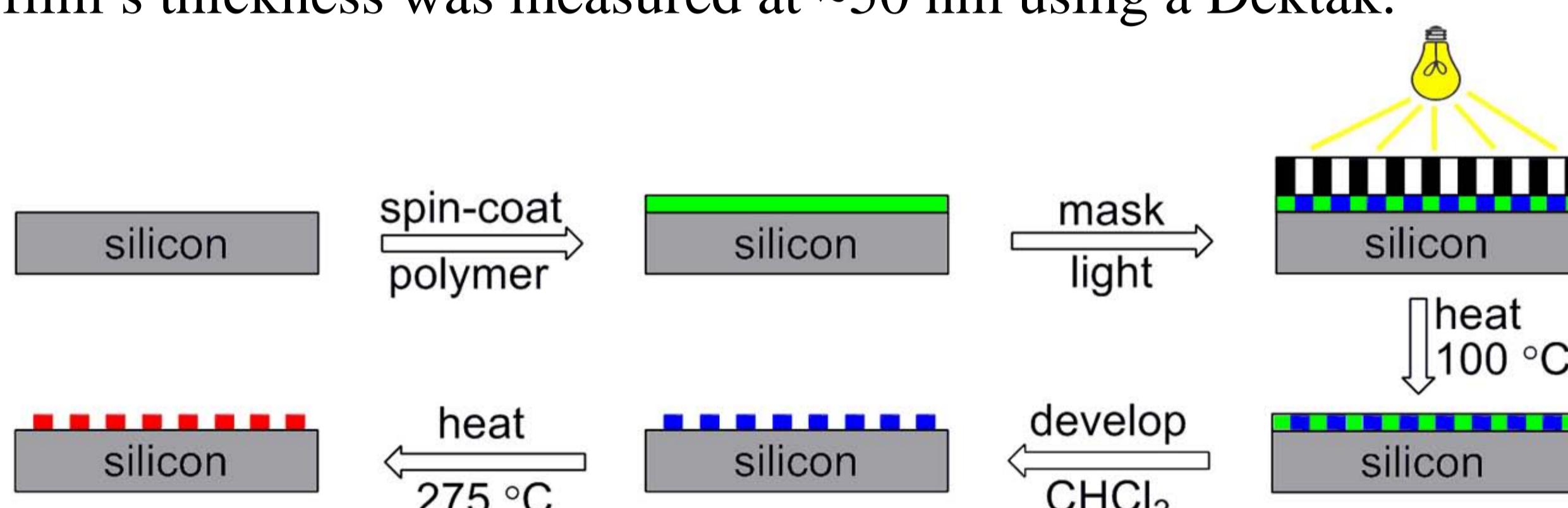
XPS indicated increased light exposure resulted in higher oxygen content of the PPV. FTIR showed additional peaks at 1692 and 1599 cm<sup>-1</sup> for the samples exposed to high intensity UV light, indicating photo-oxidation<sup>1</sup> of the vinylene bonds.



1. F. Papadimitrakopoulos, K. Konstadinidis, T. M. Miller, R. Opila, E. A. Chandross and M. E. Galvin, Chem. Mater., 1994, 6, 1563

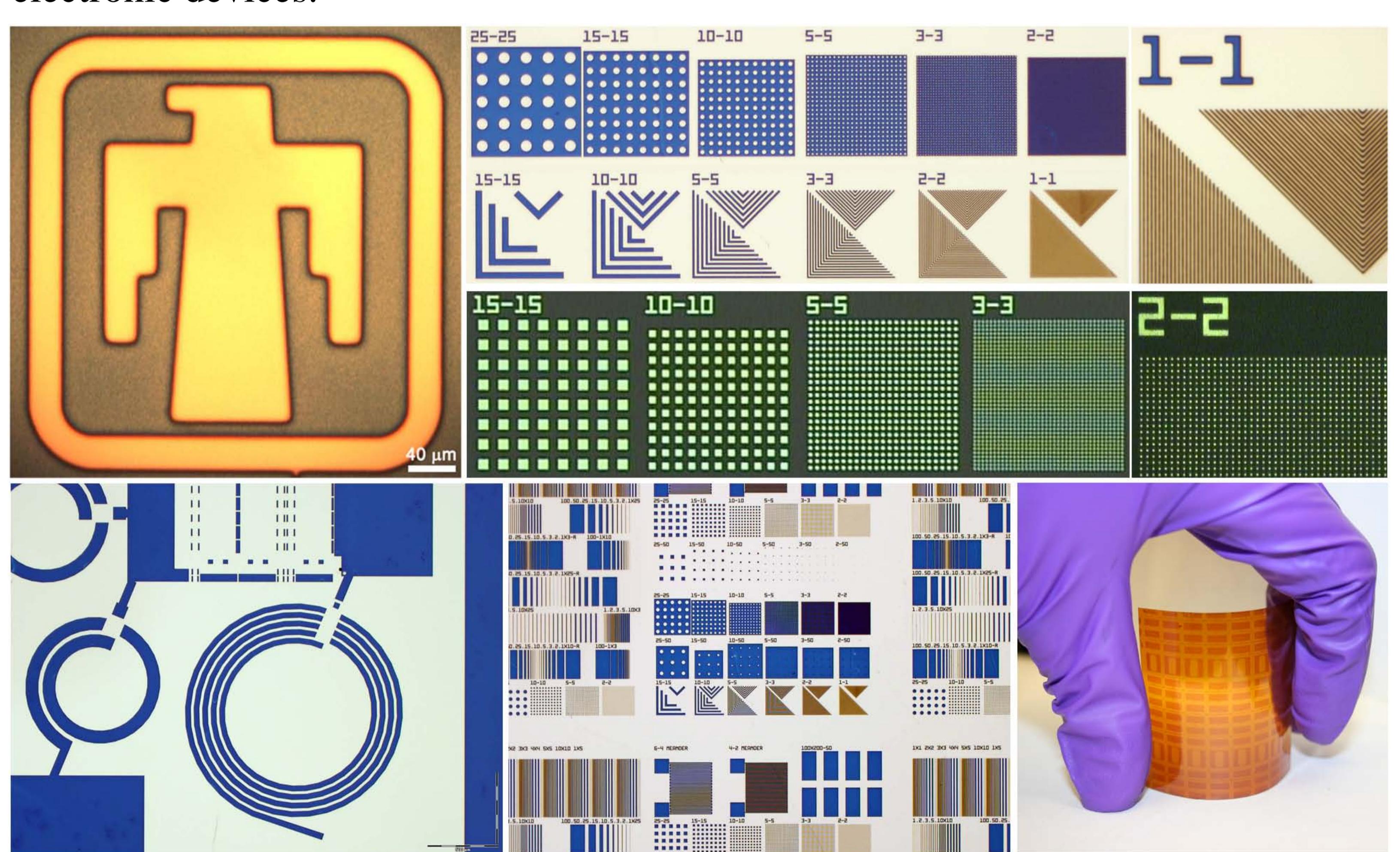
## Photopatterning Process

Solutions of the polymer (2.5% w/w in dichloroethane) were spin-coated (2,000 RPM) onto silicon wafers. A soft-bake (100 °C for 3 min) was performed to remove residual solvent. A mask was placed over the substrate and the samples were exposed to either 751 mJ/cm<sup>2</sup> from the Fusion UV system or 900 mJ/cm<sup>2</sup> of deep UV light (280-310 nm) from a collimated source. A second soft-bake (100 °C for 3 min) was performed to remove CS<sub>2</sub> and EtOH produced from the elimination reaction. The samples were developed by submerging the substrate in CHCl<sub>3</sub> for ~10 sec, which dissolved away any non-exposed polymer. Compressed N<sub>2</sub> was used to quickly remove residual CHCl<sub>3</sub>. The photopatterned material was fully converted to PPV by heating the substrate to 275 °C under a flow of N<sub>2</sub>. The polymer film's thickness was measured at ~50 nm using a Dektak.



## Optical and Fluorescence Imaging

Optical and fluorescence microscopy revealed a uniform polymer film with lateral feature sizes ranging from as small as 1 μm up to several millimeters, indicating the mask features were reproduced with high-fidelity. The precursor polymer was also patterned on flexible substrates, showing the potential for creating flexible electronic devices.



## Conductivity

Two-point probe measurements were performed to determine whether the UV exposure negatively impacted the DC conductivity of the photopatterned PPV. From IV traces, the dark conductivity of a control sample and a photopatterned sample were calculated to be 2×10<sup>15</sup> S/cm, similar to previous literature reports, and indicating the photopatterning process would not impact conductivity.

## Conclusions

We have demonstrated that xanthate precursor polymers can be photopatterned leading to micron-scale spatially-resolved PPV with little measurable effect on the materials properties. The photolithographic process outlined here is simple and direct, and should be amenable to a range of other xanthate or dithiocarbamate precursor polymers. Future work will investigate the photolithography of these and other commonly used conjugated polymer systems, as well as utilizing the improved spatial control to incorporate PPV into electroluminescent and electronic devices.