Fabrication of Polyvinyl Alcohol Micropolarizer Array

By Nathan Lazarus

Advisors: Jan Van der Spiegel

Viktor Gruev

University of Pennsylvania

Polarization

- The polarity of light reflecting off of an object contains valuable information about geometry and composition.
- The polarization can be fully expressed using the Stokes parameters:

  S0 = ITOTAL

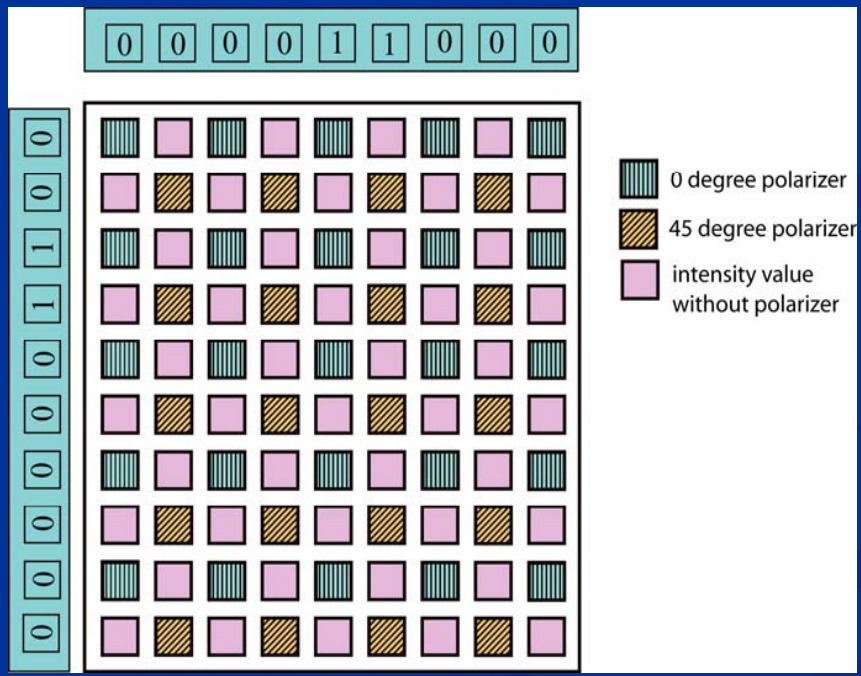
  S1 = 2*I0 – ITOTAL

  S2 = 2*I45 - ITOTAL

  S3 = ITOTAL – 2* I45,$\pi/2$
- Interested in first three stokes parameters, which characterize partially linearly polarized light.

Polarization Sensor

- A micropolarizer array is required to obtain the intensity of light polarized at 0° and 45°.



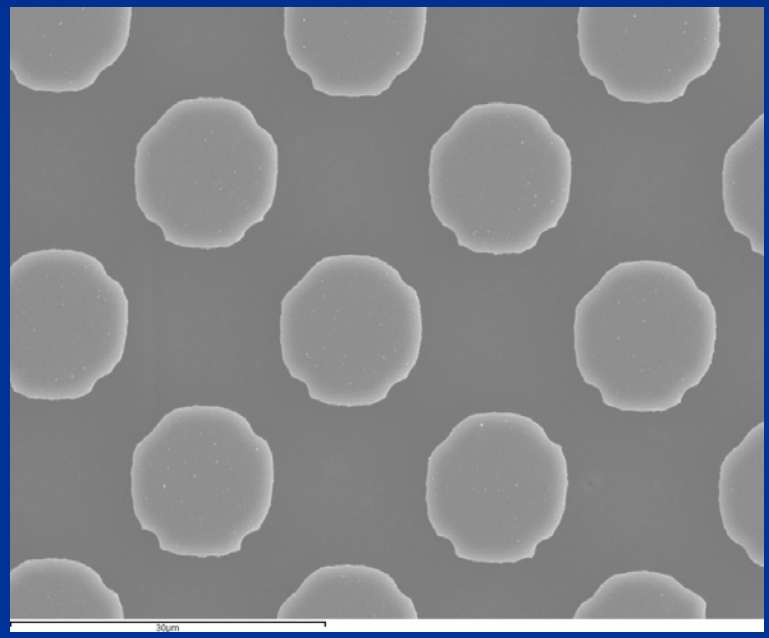
Background

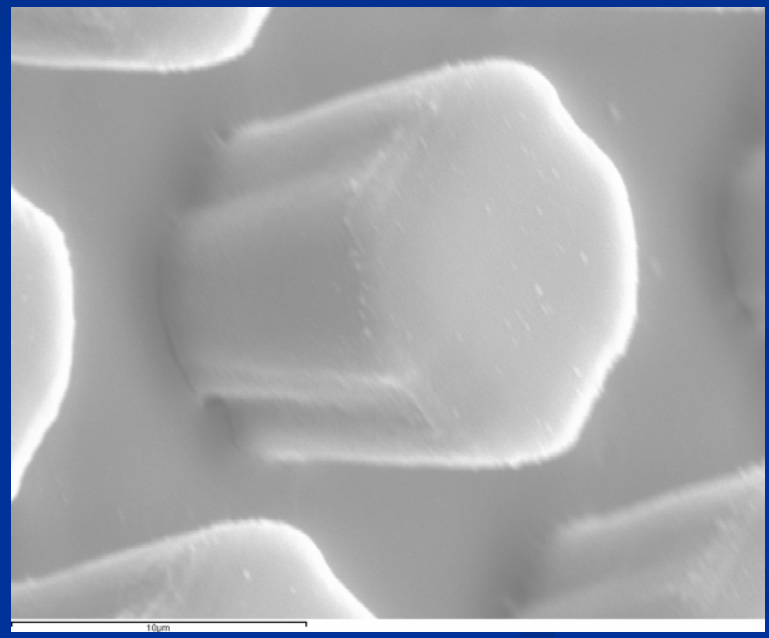
- Micropolarizers have been fabricated using etched $CaCO_3$ crystal, metal gratings, and liquid crystal.
- Past work using PVA films have achieved resolution as small as 25 microns.
- Our image sensor will require 10 microns micropolarizers.

Method

- PVA layer isolated by removing protective backing material.
- Photoresist structures created on top of PVA using photolithography.
- Areas not protected by photoresist etched away.

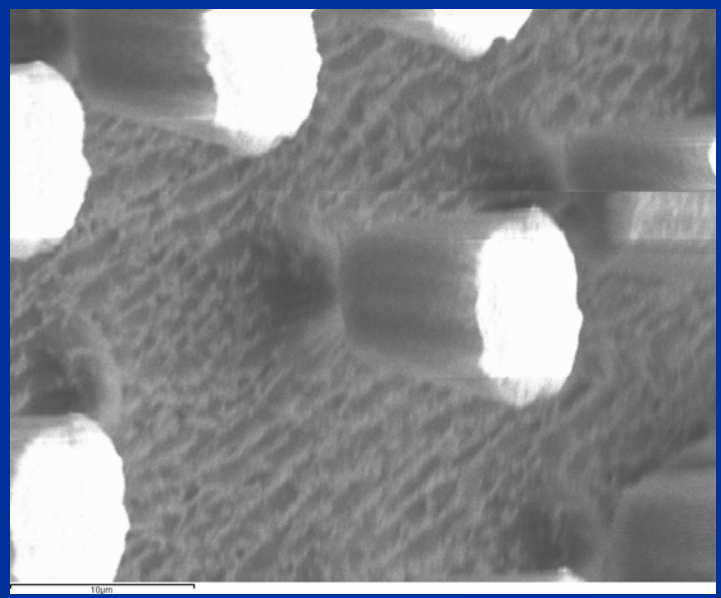
Photolithography

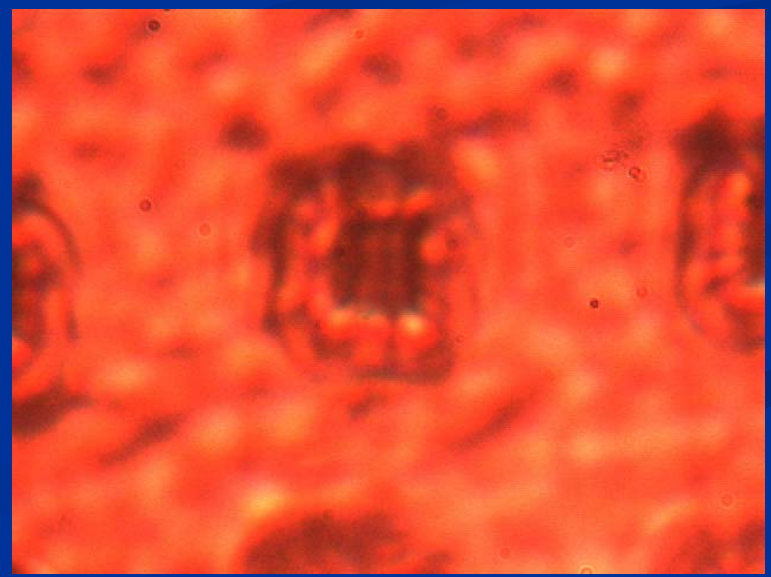




Plasma Etching

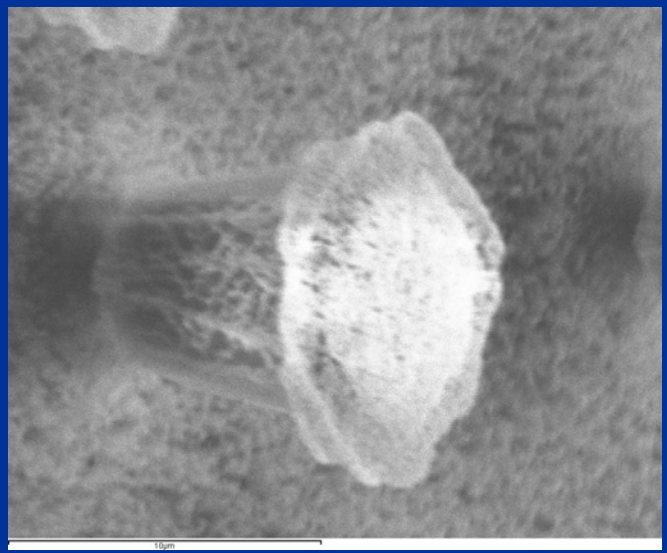
- PVA etched with plasma mixture of CF_4 and oxygen.
- Plasma reacts chemically to remove PVA in areas not covered with photoresist.

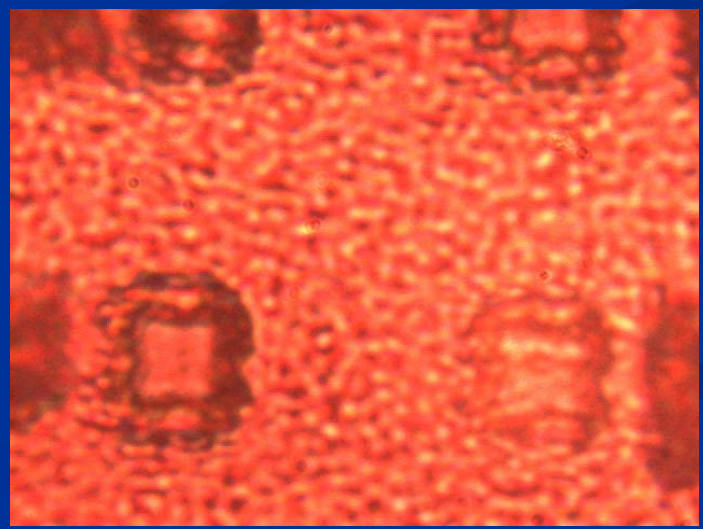




Reactive Ion Etching

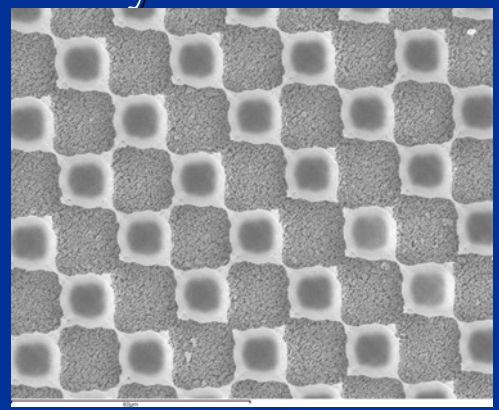
- PVA etched with a mixture of O_2 and Ar plasma.
- Argon physically removes particles by striking the sample at high speeds.





Microfabrication

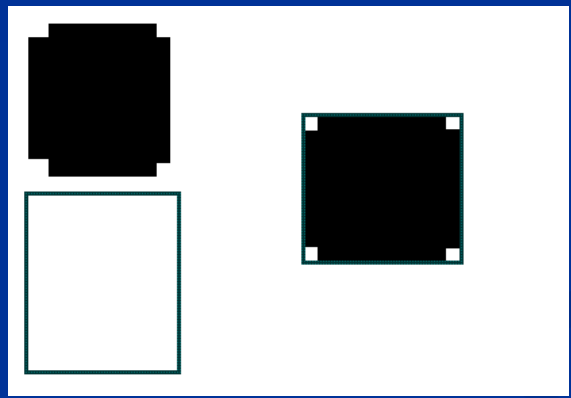
- Sensitive to environmental factors such as temperature and humidity.
- Loss of adhesion
- Overexposure



- Loss of structure during etching.

Multilayer Array

- Need to be able to place layers in the proper locations relative to each other.



- To bond layers, UV curing glue is used to coat one layer, second layer is brought into contact, and sample is exposed to UV light.

Summary

- Successfully created a single layer of micropolarizers in pattern needed for final sensor.
- Refined fabrication technique to minimize underetching.
- Preliminary work toward multi-layer array.

Future Work

- Refining gluing technique to allow bond without covering pads.
- Design mask to allow alignment of multiple layers.
- Fabricate final image sensor using these techniques.