

Introduction

- A method to manufacture the optical component of an Artificial Photosynthesis (AP) prototype needs to be developed.
 - The method must be flexible as the design requirements may change rapidly
- A high optical quality is required which demands high surface quality of the cavities, mold quality, and design.
- Injection molding is chosen as the manufacturing process of the optical component.

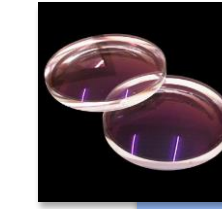
Requirements



Material

- Transparency
- High UV transmission
- Weathering resistance
- Chemical resistance

PMMA (Acrylite)



Lens Design

- Geometrical boundaries
- Gathering and focusing sunlight
- Seal AP device from environment

Plano-convex Lens

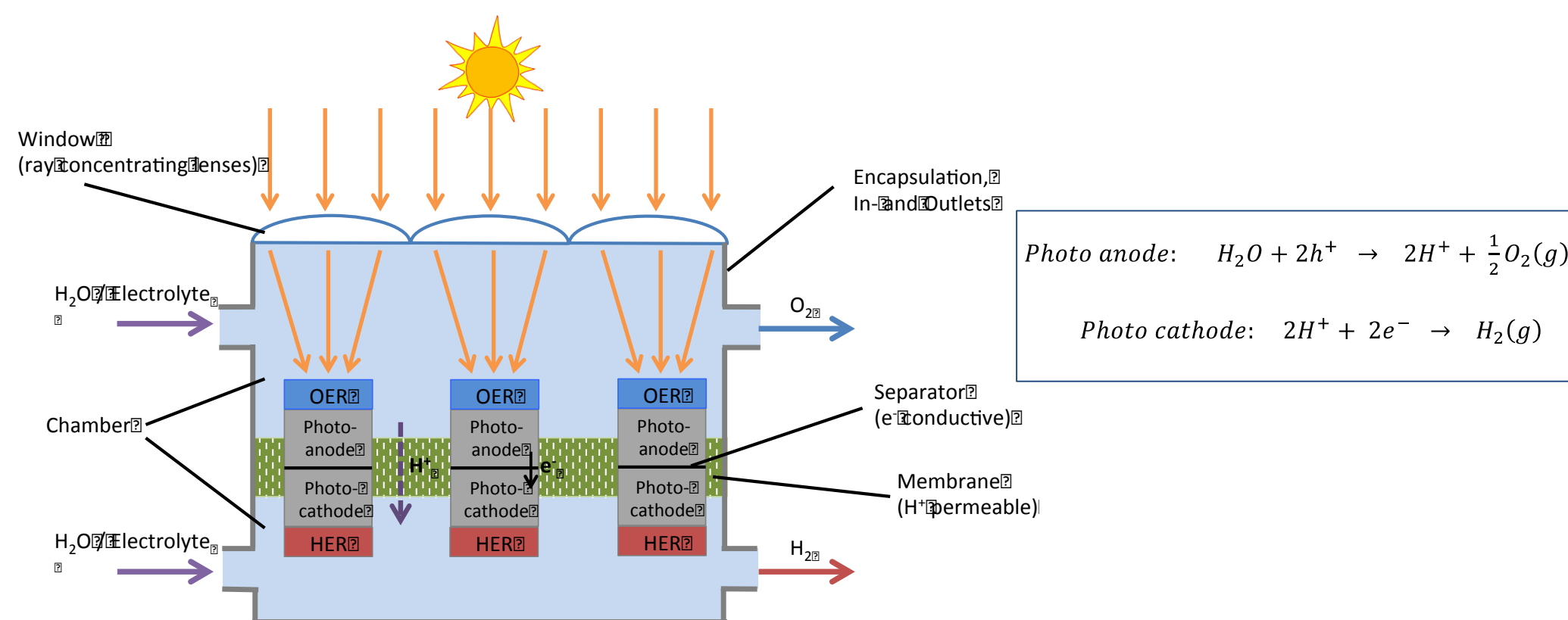


Manufacturing

- Prototyping phase
- Rapid response and flexibility
- Scalability and reproducibility
- Cost-effective

Injection Molding

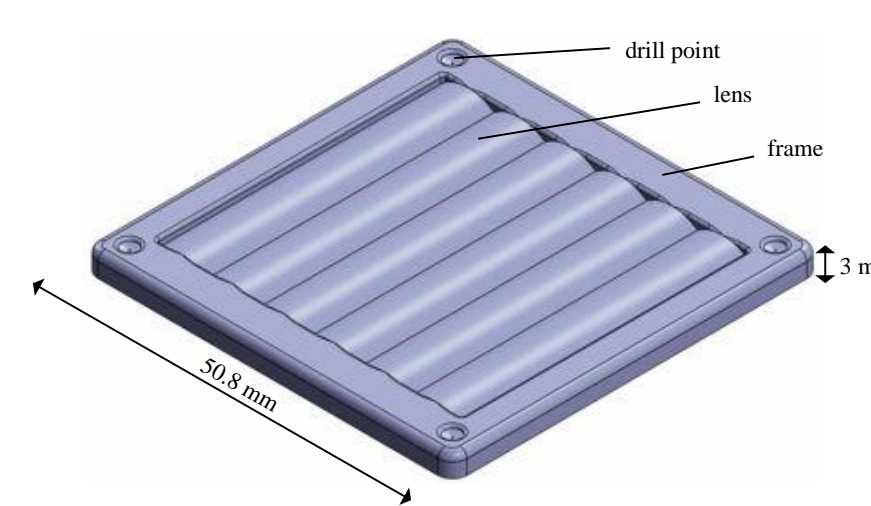
Principle Process in AP Device



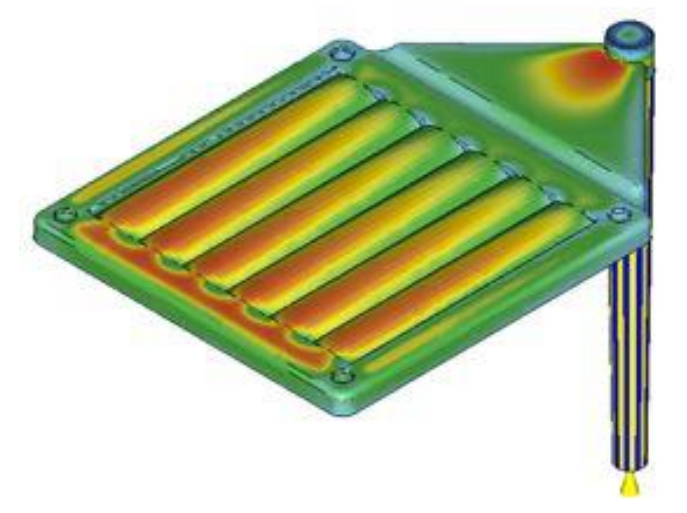
- Absorption of solar photon in semiconductor leads to the excitation of an electron-hole pair.
- Oxidation of water by holes at the photo-anode: OER.
- Transport of hydrogen protons from the photo anode to the photo cathode through the H₂ permeable membrane which is impermeable for gases.
- At the photo-cathode the electrons reduce protons to evolve hydrogen: HER.

Design Process

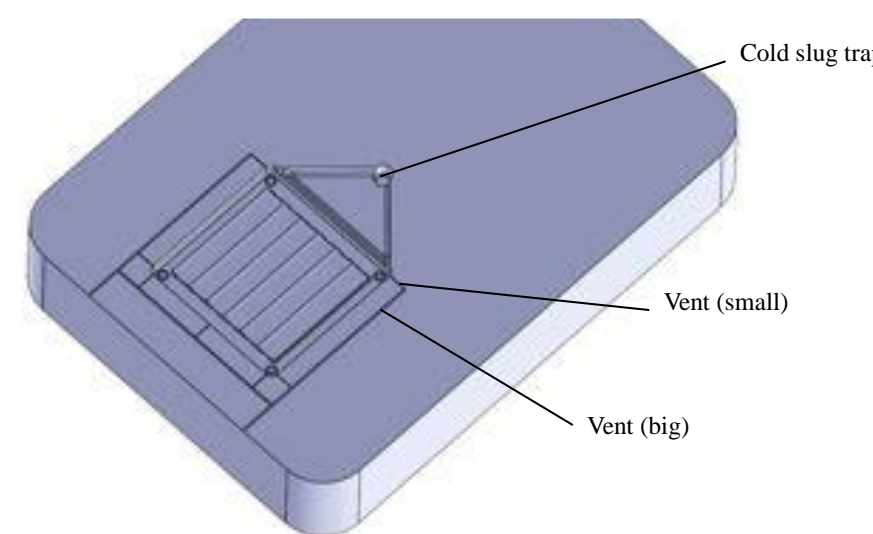
Optical component design



Moldflow simulation



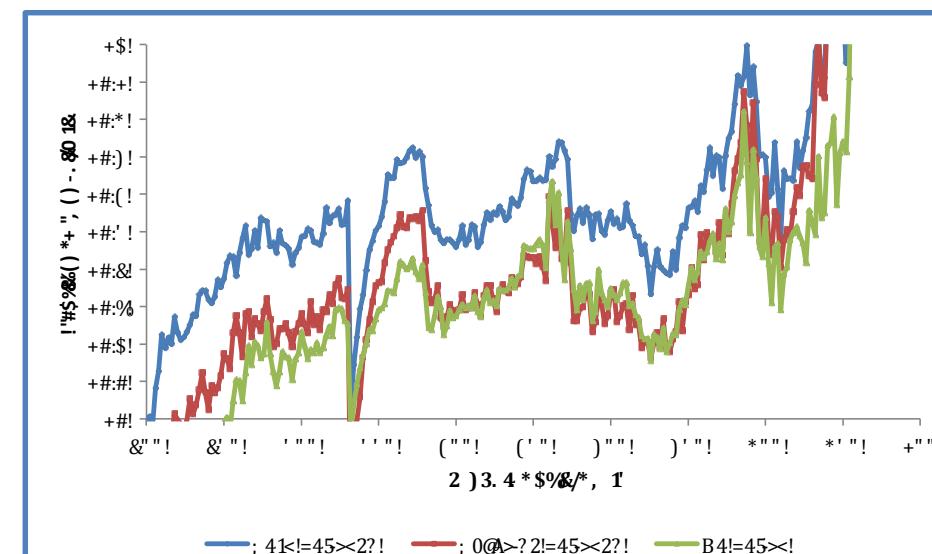
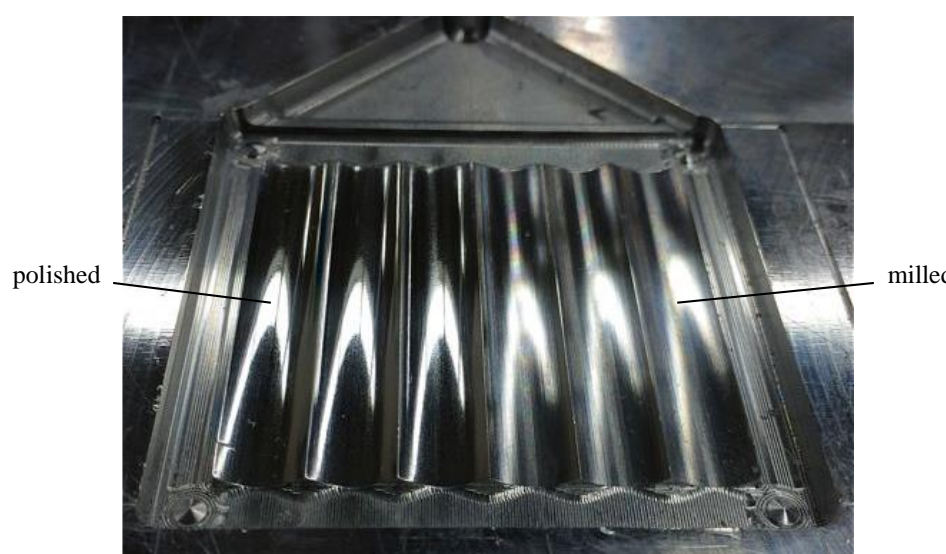
Mold design – aluminum mold



Focal length measurement



Results



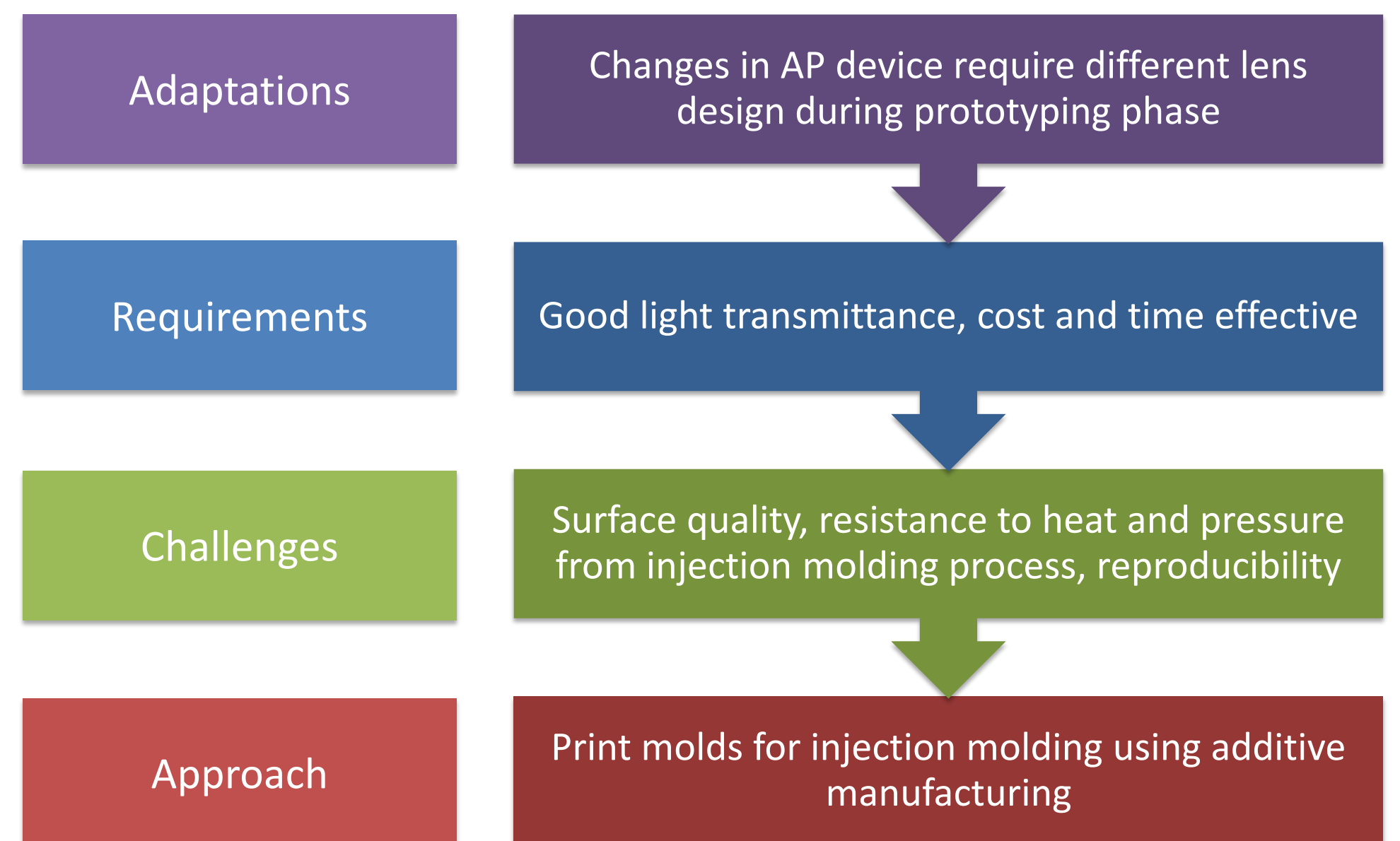
- Three different surface finish stages were tested for light transmittance
- Cavity was hand polished starting with sandpaper, finishing with diamond paste
- Focal length was measured

Polished cavity reaches 91% light transmittance at 400nm

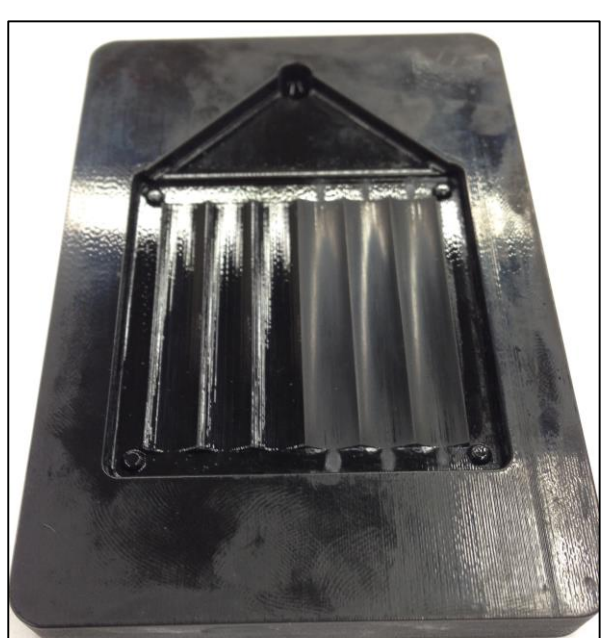
Measured focal length of 12.32mm meets modeled dimensions of 12.25mm

Reproducible lenses without air traps and weld lines can be manufactured

Additive Manufacturing

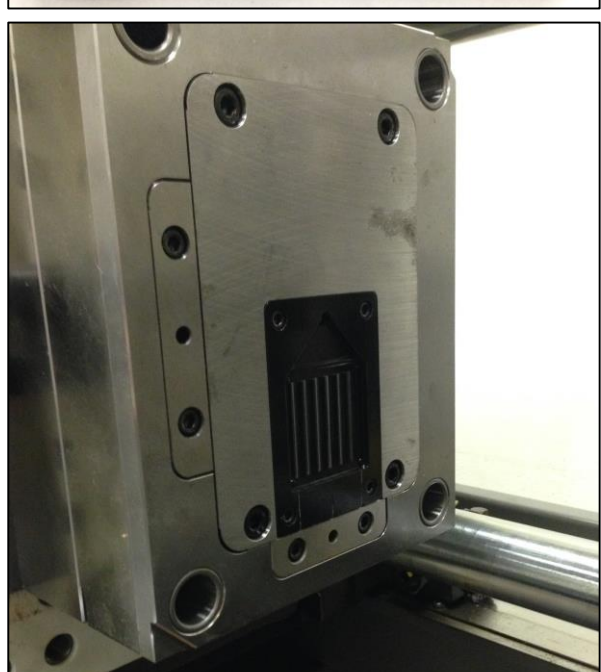


First Steps



3D printed mold

- Same lens design – comparable to aluminum mold
- Printed with Stratasys Object350 Connex
- Partly polished for better surface finish



Mold mounted in clamping unit

- Milled box in steel plate enables easy changing of mold
- Adjustment of injection parameters
- Up to 20 lenses could be produced before mold showed defects

Future Work

- Analyze additive manufactured molds
 - Testing different materials and printing technologies
 - Investigate surface treatments (mechanical, chemical)
 - Compare results to aluminum mold
- Change design of lens/mold
 - Lenses which do not require a sun tracking system
 - Fresnel lenses