ABSORBER COATINGS FOR MID-INFRARED ASTROPHYSICS

DAHLIA BAKER[1], EDWARD WOLLACK[2] , KARWAN ROSTEM[2,3]

1. COE COLLEGE, DEPARTMENT OF PHYSICS
2. OBSERVATIONAL COSMOLOGY LAB, NASA GODDARD SPACE FLIGHT CENTER
3. DEPARTMENT OF PHYSICS AND ASTRONOMY, THE JOHNS HOPKINS UNIVERSITY

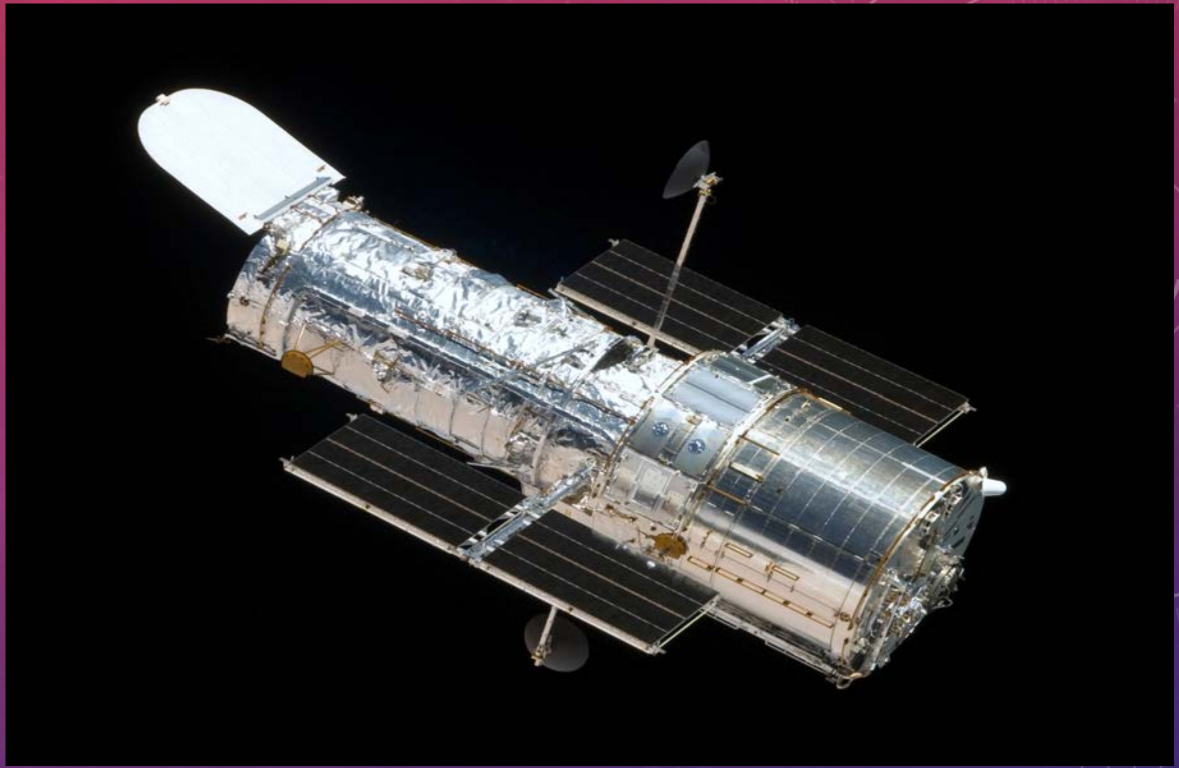
ABOUT ME

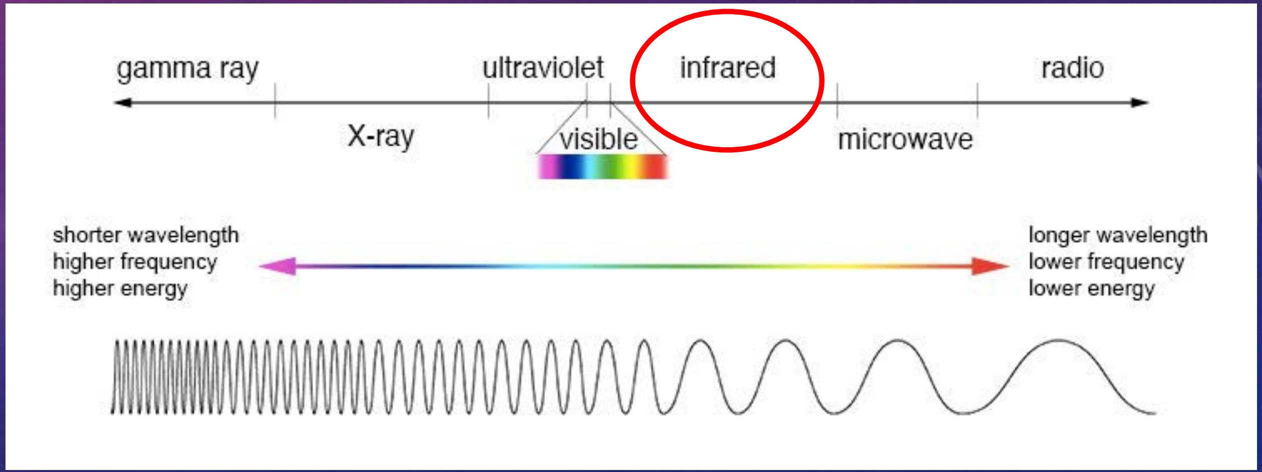
- Physics and Mathematic Major
- Physics Club and Outreach
- Studied Computational Biophysics, moving on to Planetary Science research

BACKGROUND

- HIRMES - High Resolution Mid-InfrarEd Spectrometer
    - Functioning in the 20-200 micrometer range
        - Eliminate

- SOFIA – Stratospheric Observatory for Infrared Astronomy

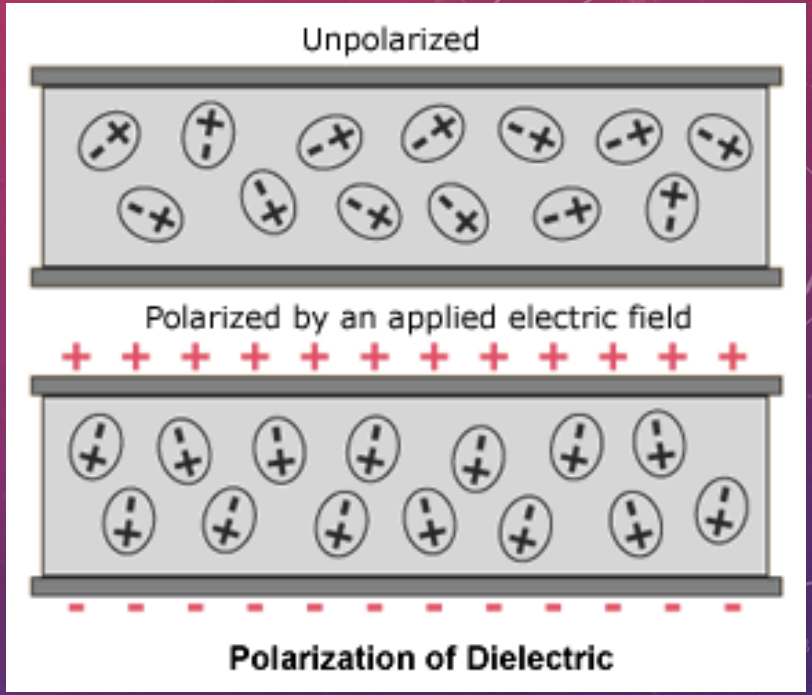


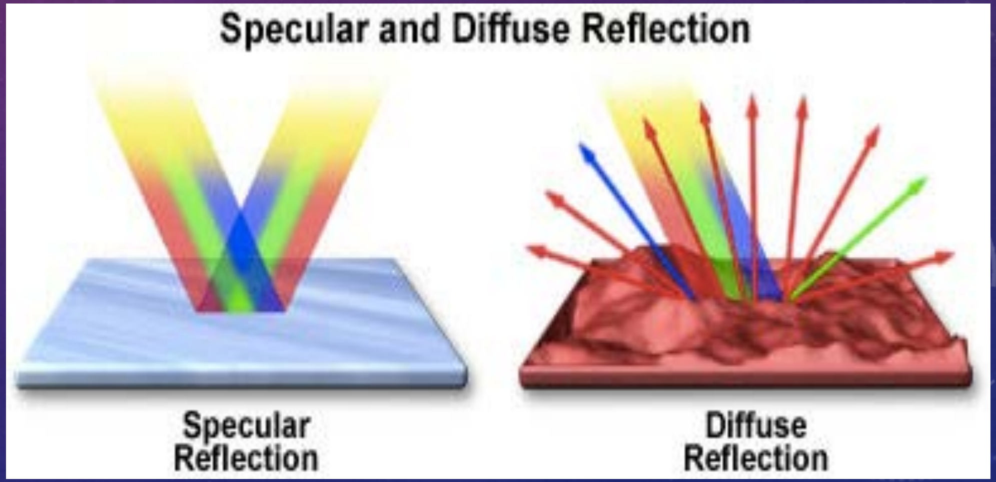


APPROACH

- *Goals*
  - Create a material that absorbs stray light
  - Lightweight, easy applicable
  - Known dielectric function
    - What is this?
      Describes the electric response to incident radiation
  - Diffusively reflects rather than specularly reflects
  - Withstand cryogenic temperatures (μK)

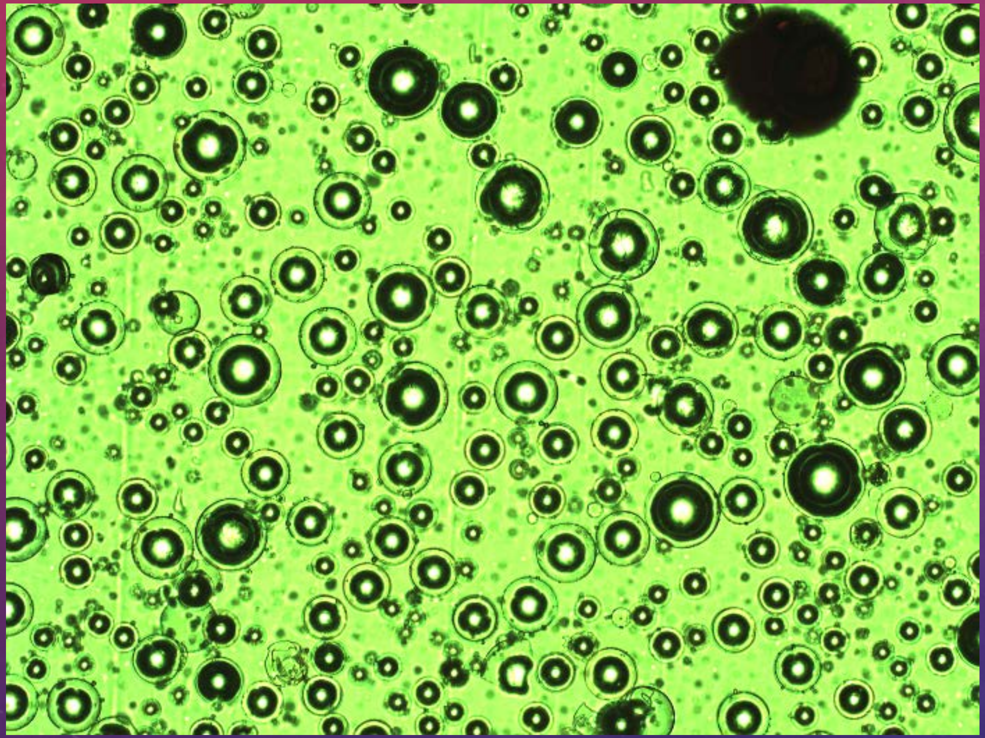
- *First Step-* Characterize the materials
    - Dielectric functions
- *Second Step-* Matlab Model
  - Model each sample layer with found dielectric function
- *Third Step-* Manufacturing
  - Create sample plates





APPROACH

3M Glass Microspheres
~100 microns in diameter



Epotech 377H Graphene- Loaded Epoxy
sC(5):377(65):SiOx(30)

Specular

Diffuse

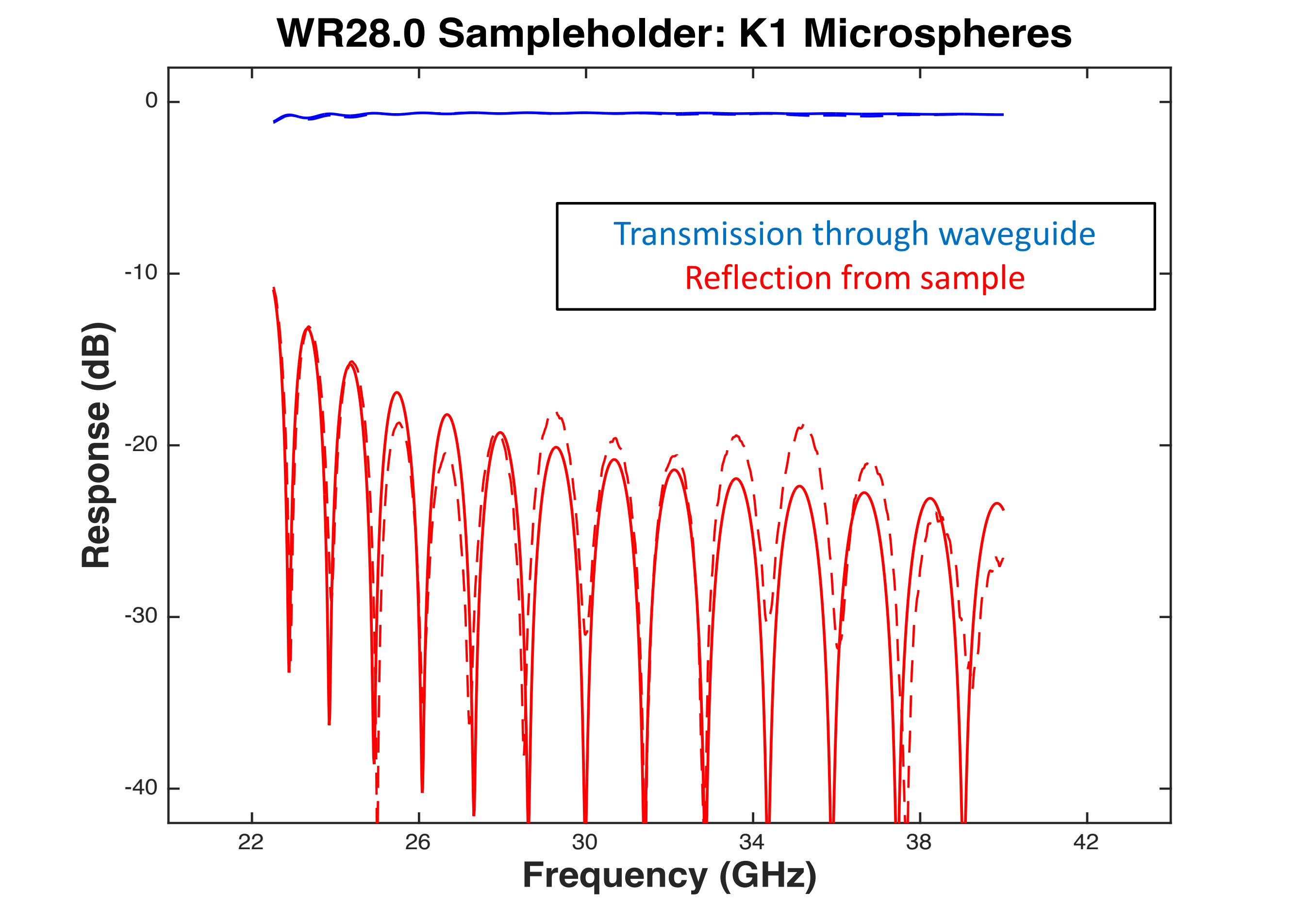
Aeroglaze Z306

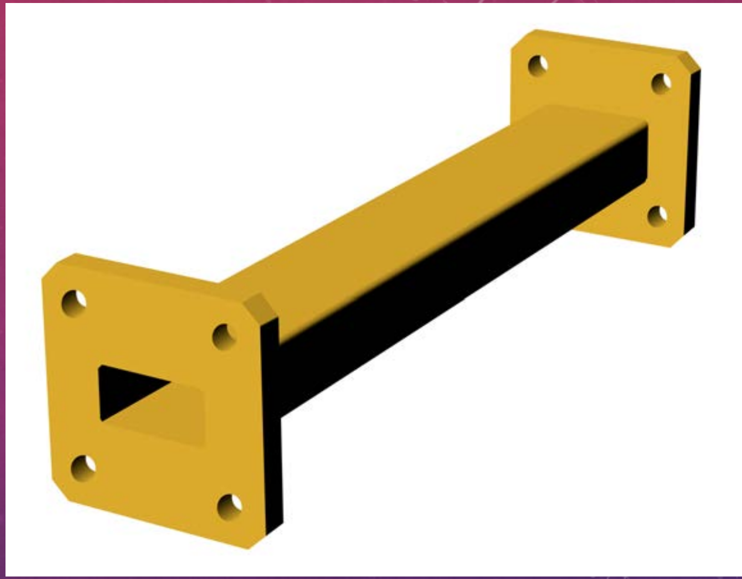
SAMPLES

Sample Letter	Thickness of Epoxy (µm)	Final Layer Count	Composition (Layer Order)
A	579	2	Epoxy, Z306
B	644	3	Epoxy, Z306, K1
C	449	3	Epoxy, K1, Z306
D	505	4	Epoxy, K1, Z306, K1
E	707	1	Epoxy
F	494	2	Epoxy, K1

DIELECTRIC CHARACTERIZATION

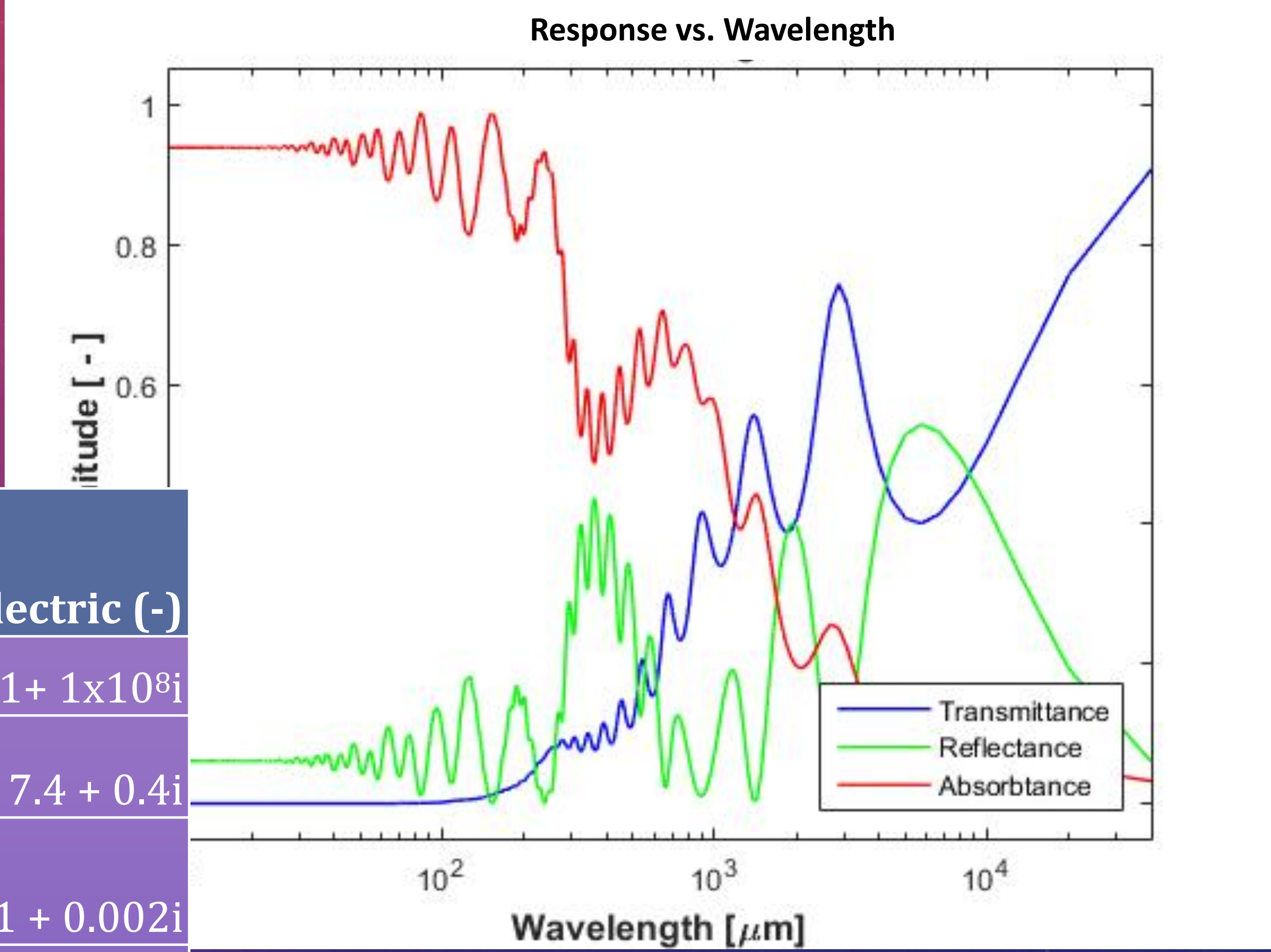
- Frequency response data taken with a microwave network vector analyzer





- Periodic structure of reflection shows constructive and destructive interference
- Shows the "true density" as seen by an incident electromagnetic wave
- Loss is due to dielectric properties of microspheres, scattering due to geometry is not considered

THE MODEL



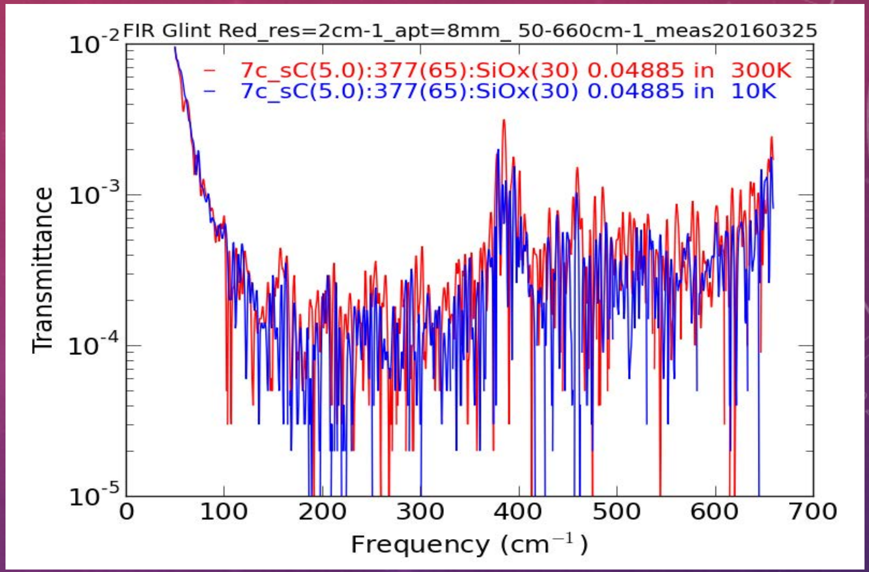
Material	Thickness (µm)	Dielectric (-)
Aluminum	500	$1+ 1x10^8i$
Epoxy 377H	500	7.4 + 0.4i
3M K1 Microspheres	100	1.1 + 0.002i
Aeroglaze Z306	50	2.6 + 0.6i

RESULTS

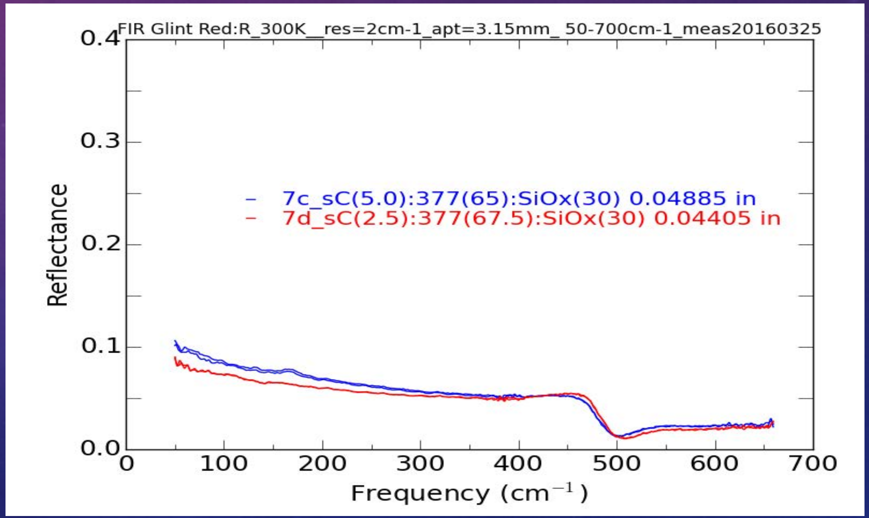
- *Conclusions*
  - Our proposed material can be manufactured at a small scale
  - Model predicts correct response
  - Drawback – model cannot predict response from diffuse scattering due to microspheres

- *Further Studies*
  - Measure optical frequency-dependent response with a Fourier Transform Spectrometer

Transmittance vs. Frequency for Epoxy



Reflectance vs. Frequency for Epoxy



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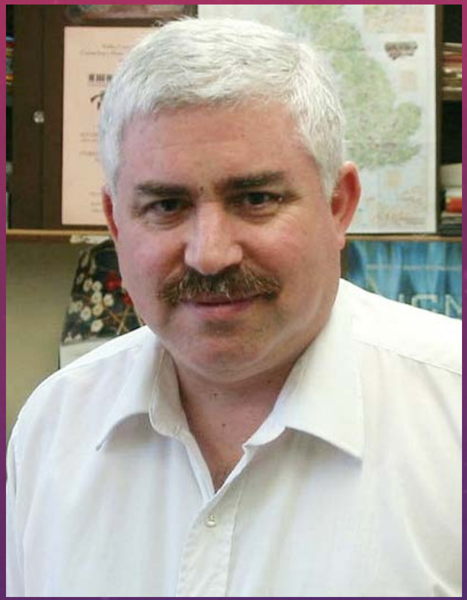

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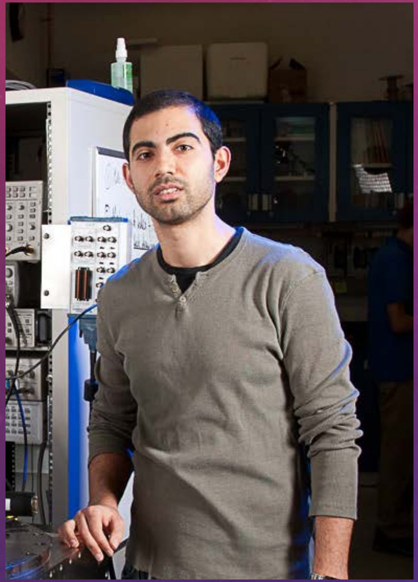

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