



SOCIETY OF PHYSICS STUDENTS
An organization of the American Institute of Physics



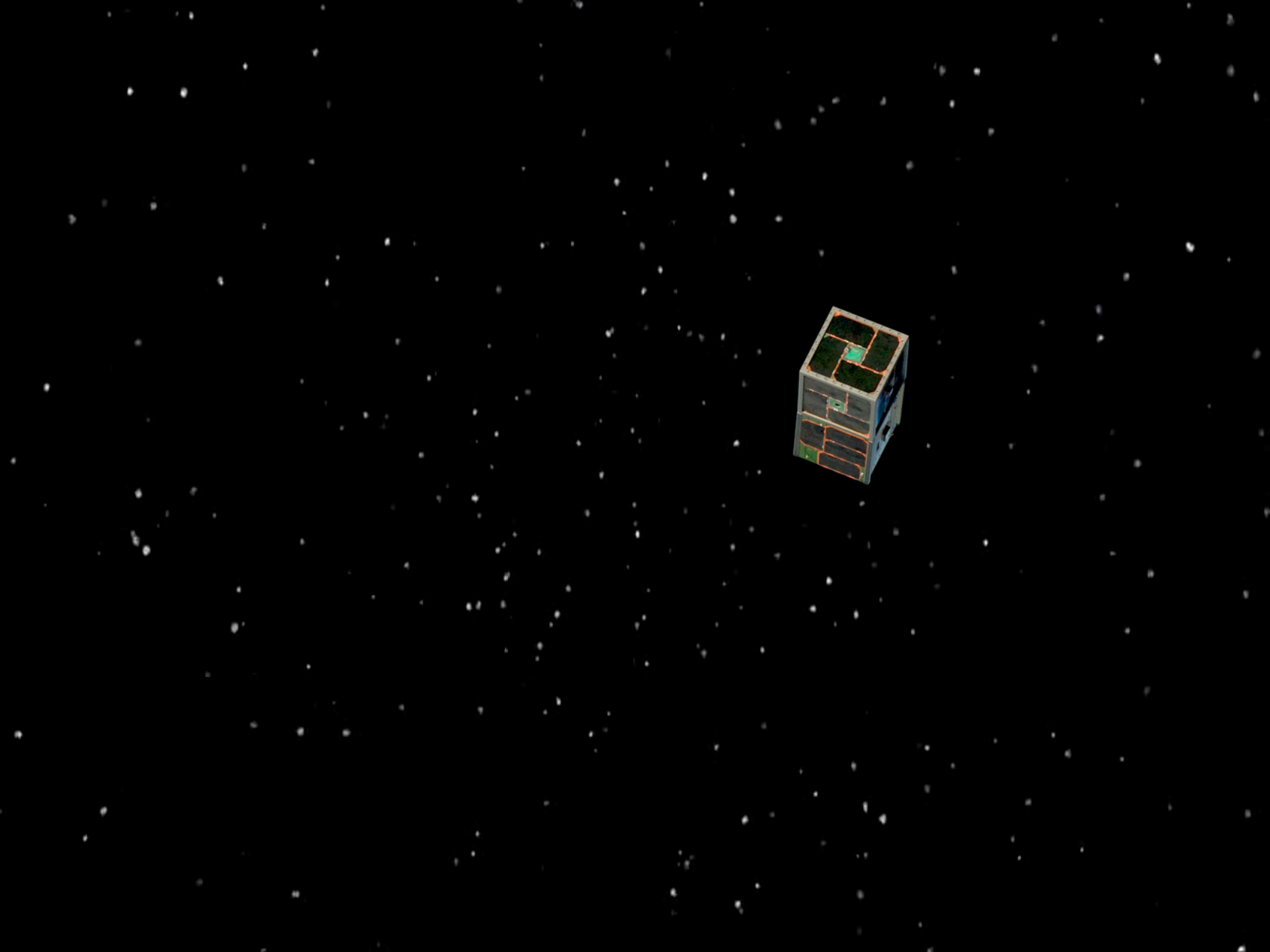
Simulating Infrared Transmission Through a Porous Dielectric Foam

Max Torke

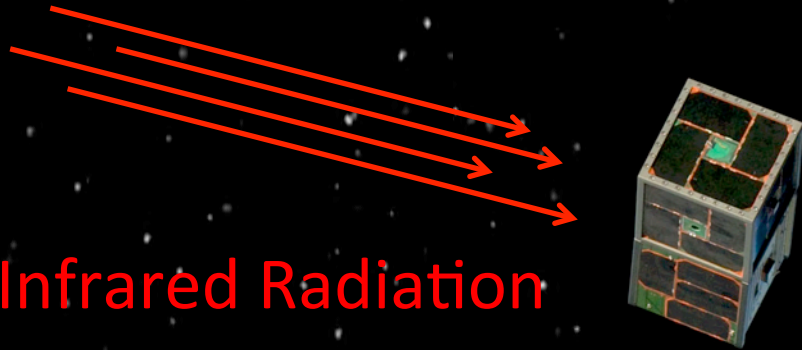
Sonoma State University

Dr. Edward Wollack

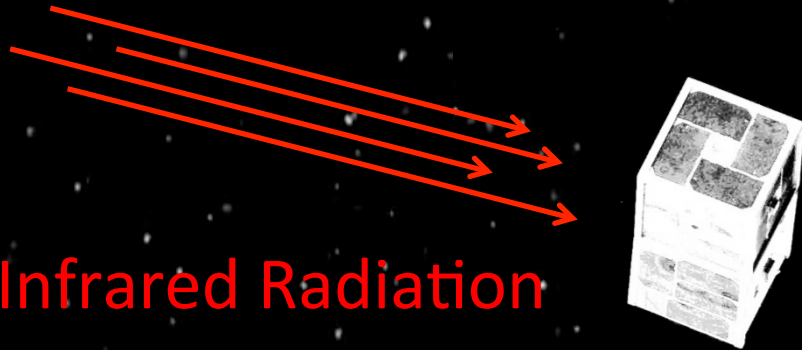
NASA Goddard Space Flight Center



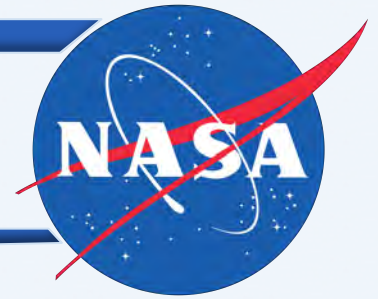
Infrared Radiation



Infrared Radiation

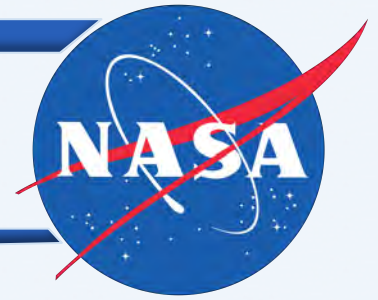


Dielectric Foam

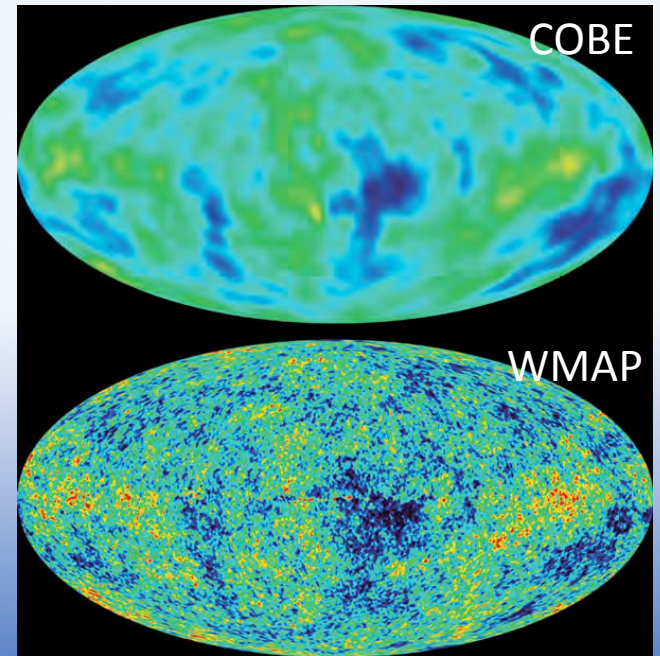


- Filter
 - Allows transmission of preferred frequency, excludes unwanted frequencies
- Absorption, reflection, scattering

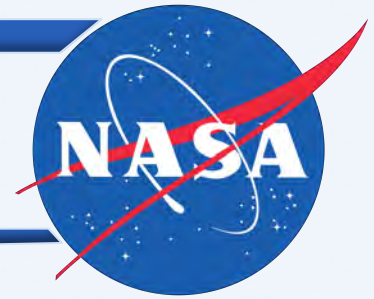
Potential Applications



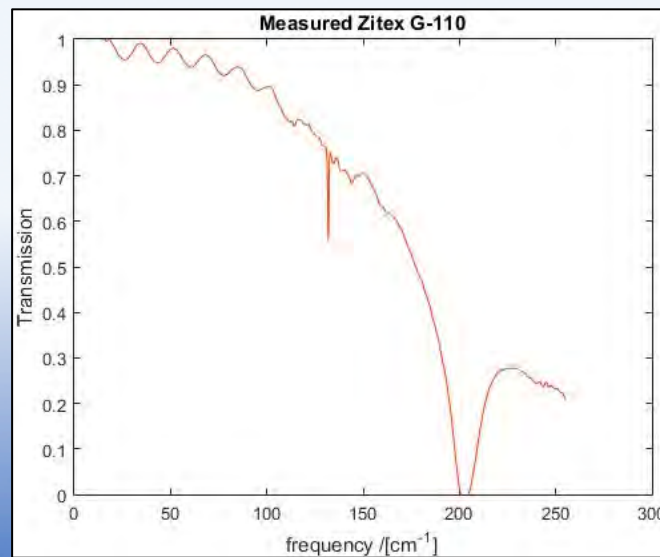
- ICESat-2
 - Cryogenically cooled detectors
- Cosmic Microwave Background satellites
 - Reduce measurement noise



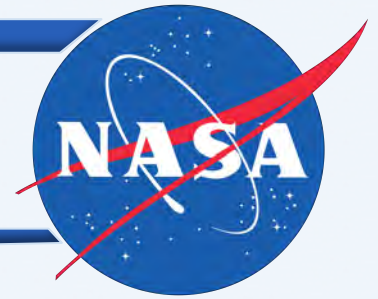
Project Goal



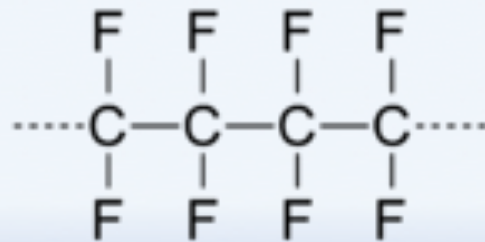
- Simulate transmission of infrared radiation
 - Reflection, absorption, scattering thermal infrared radiation
- **Determine optimal dielectric width** by generating plots of transmission vs. frequency



What is Zitex?

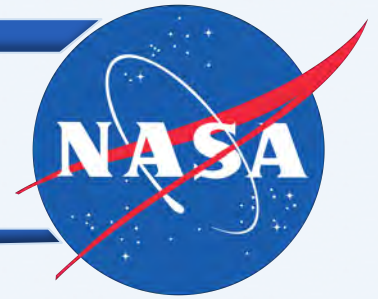


- Fibrous-porous Teflon
- Zitex can be used as a frequency filter for infrared radiation



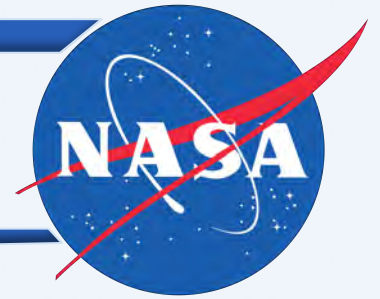
PTFE

Simulator Variables

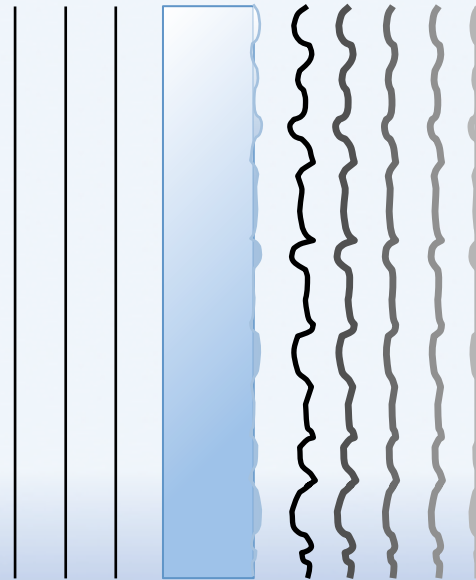


- Electric permittivity
 - Propagation of light
 - Absorption (scattering is function of squared freq.)
- Absorption poles
 - Absorption strength
 - Absorption frequencies
- Phase decoherence

Decoherence

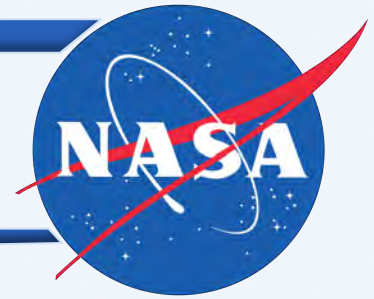


- Initial decoherence of incident wave
- Decoherence due to surface roughness

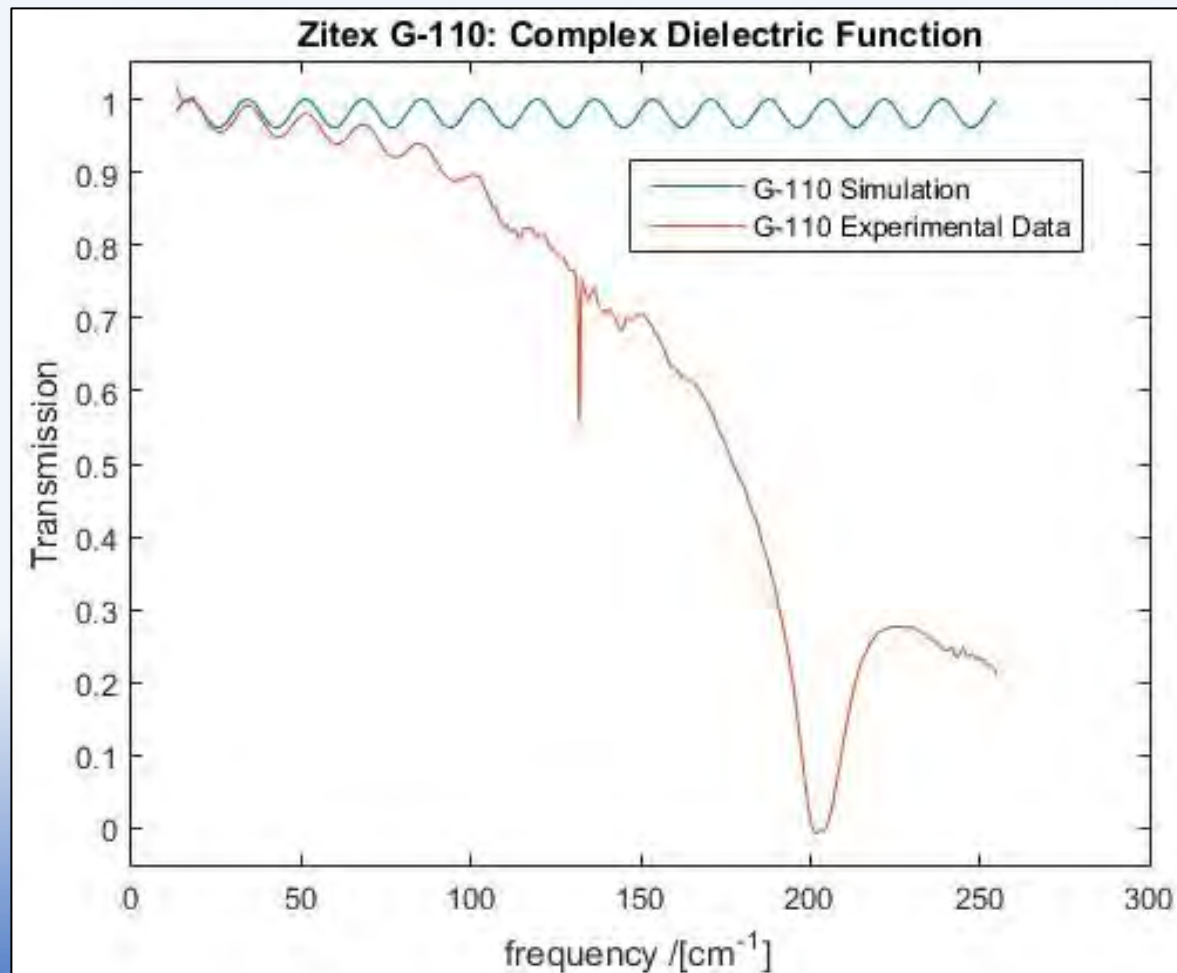


Rough surface causing
decoherence

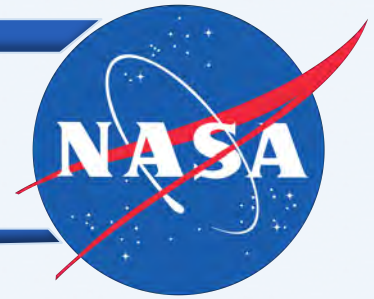
Zitex G-110 Data



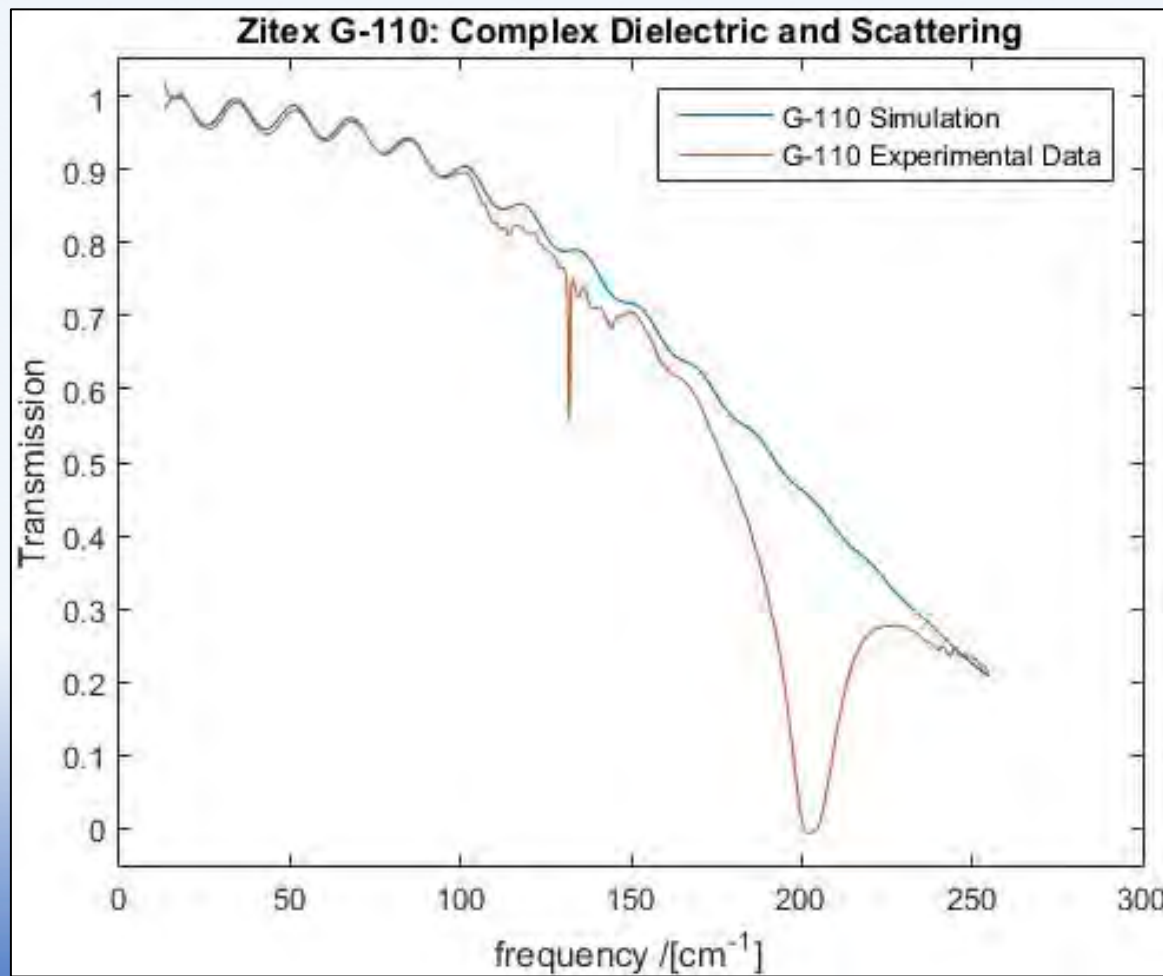
- Complex dielectric constant



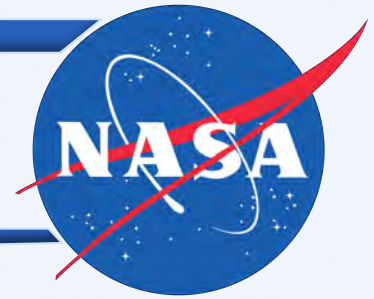
Zitex G-110 Data



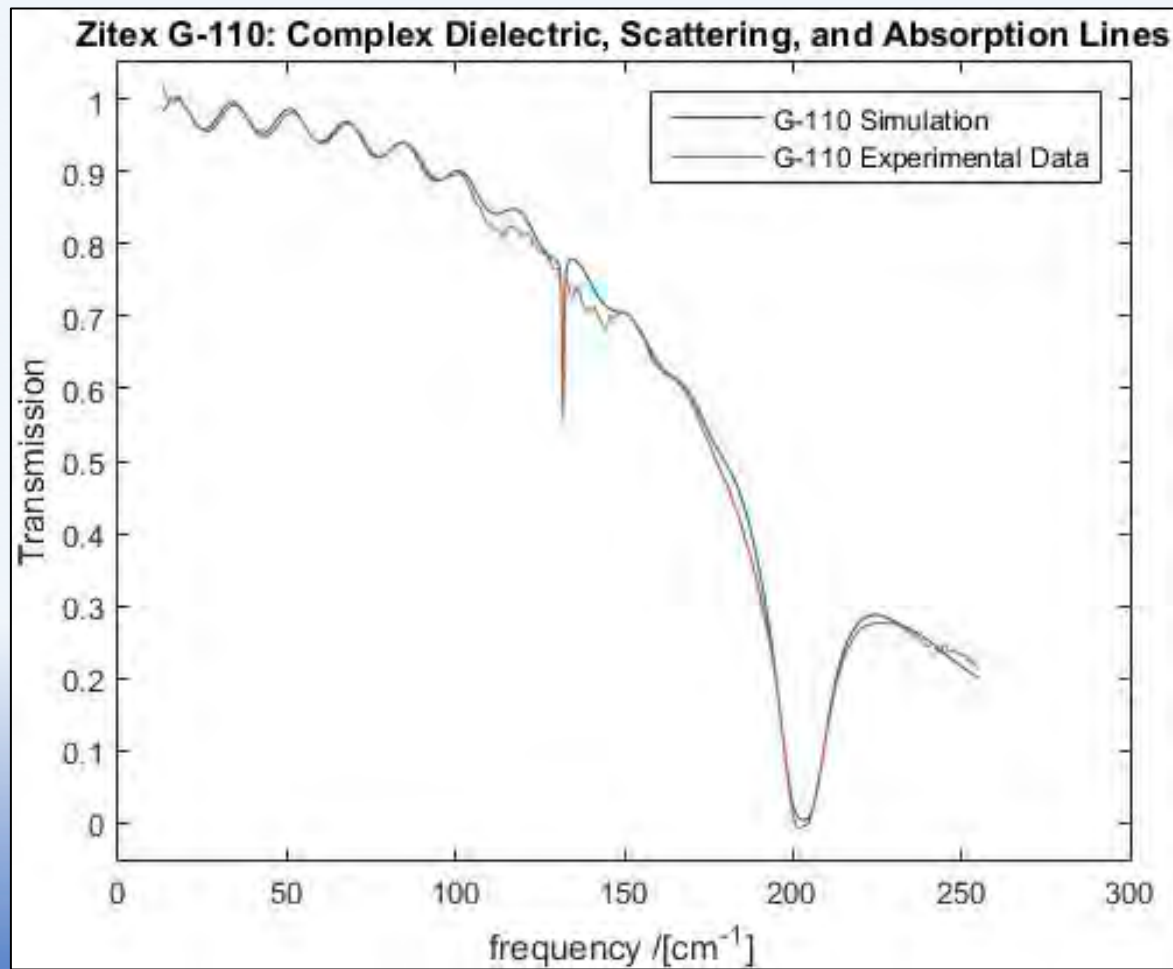
- Add scattering effect, dielectric function



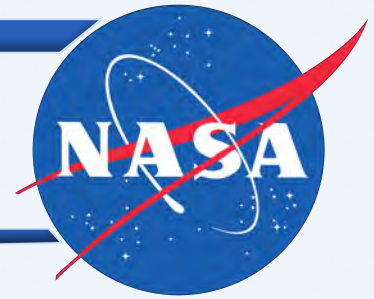
Zitex G-110 Data



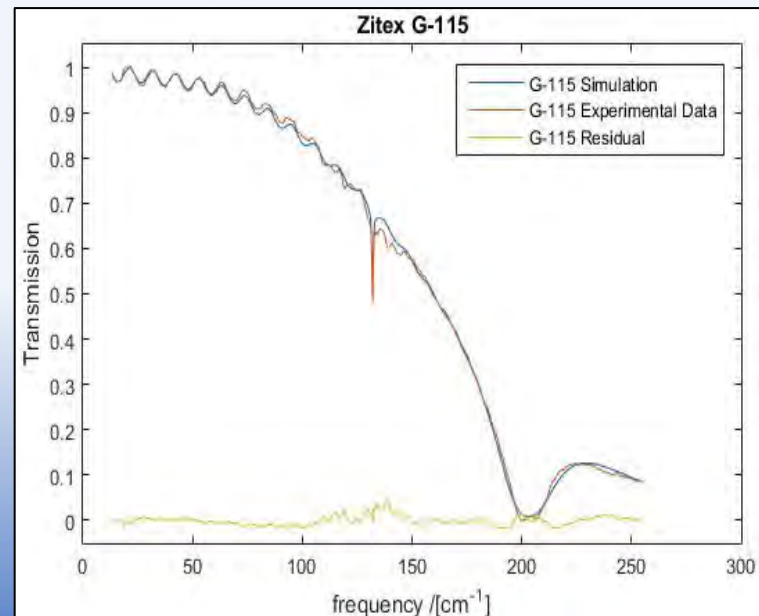
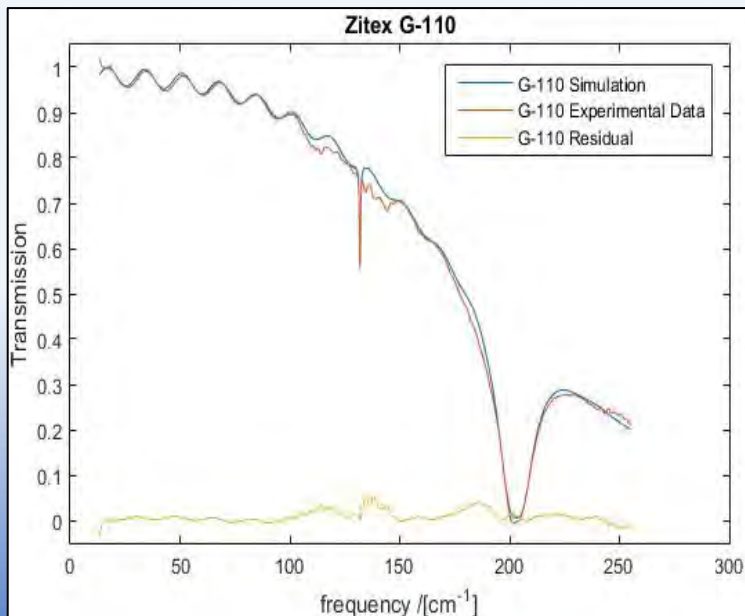
- Add rotational absorption poles



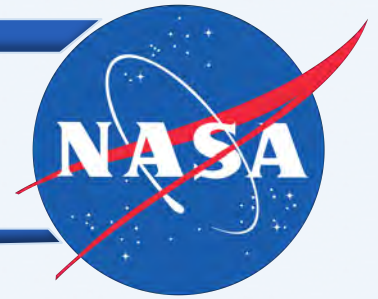
Results



- Developed simulator that accurately fits measured spectra
- Can be used to determine optimal dielectric width

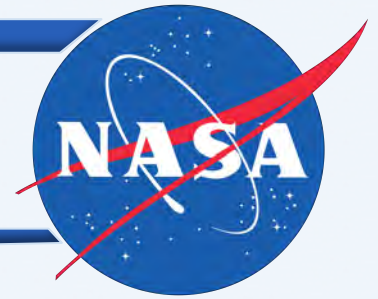


Acknowledgements



- NASA
 - Edward Wollack
 - Mablelene Burrell
 - Robert E. Gabrys
 - Felipe Colazo Petit
 - Karwan Rostem
- AIP
 - Sean Bentley, Kendra Redmond, Courtney Lemon
- Peter Rooney

References



1. P. F. Goldsmith, "Quasioptical Systems: Gaussian Beam Quasioptical Propagation and Applications," (IEEE Press, 1998) pp. 231-235
2. E. N. Grossman and D. G. McDonald, Optical Engineering 34, 1289 (1995)
3. P. Yeh, "Optical Waves in Layered Media," (John Wiley & Sons, 1988)
4. E. Palik, "Handbook of Optical Constants of Solids," (Elsevier, 1998) Chap. 2, p. 15
5. D. M. Pozar, Microwave Engineering, 4th ed. (John Wiley and Sons, Inc., 2011)