SAND2015-5350C

Implementation of Single-Shot Ellipsometry on Gas Gun Experiments

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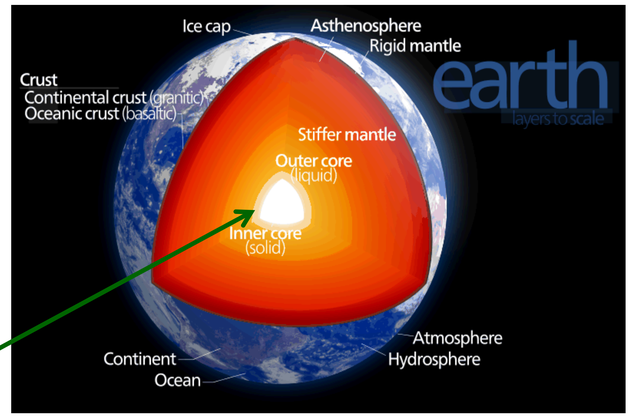
Introduction:

Our ultimate goal is to measure the conductivity of iron at Earth-core conditions; current theoretical estimates for the conductivity vary by a factor of three.

Why Iron Conductivity?:

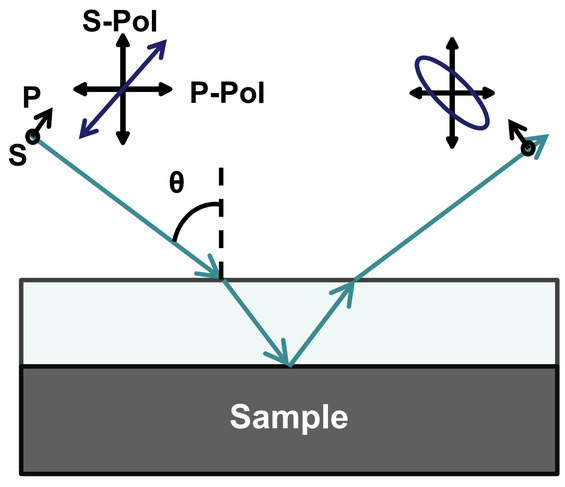
The conductivity of iron is a critical parameter in models of the Earth's core and the geodynamo – the dynamo action in the Earth's outer core which maintains the magnetic field via convection.

Inner Core Boundary (ICB): 330 GPa, ~5500K

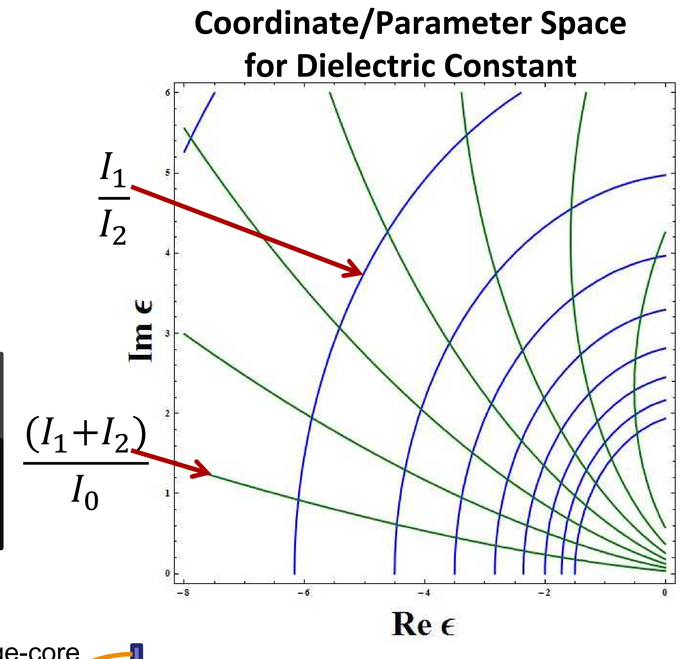


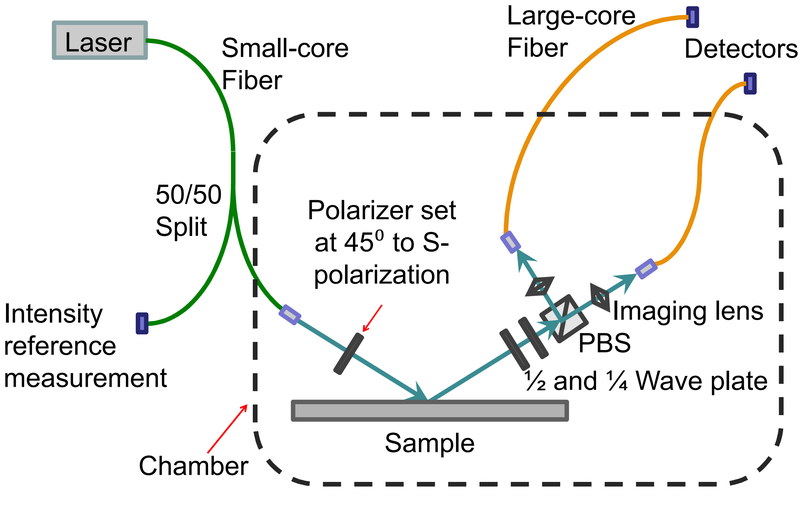
Probing Conductivity:

To measure the conductivity we will use time-resolved ellipsometry, which analyzes the change in polarization of a light beam after reflecting off a sample.



Coordinate/Parameter Space for Dielectric Constant



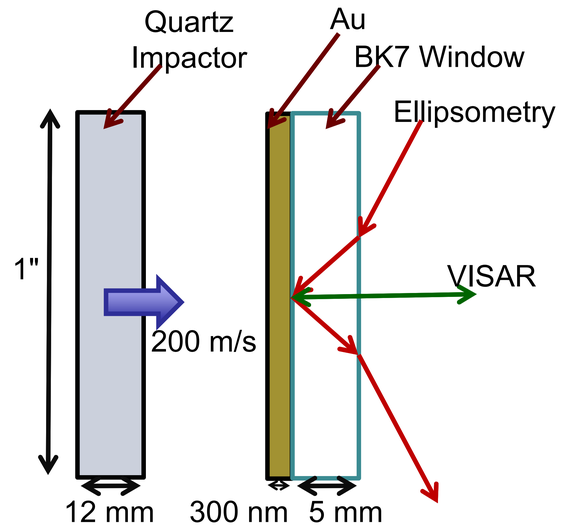


Probe Design:

This design incorporates open-beam polarizing optics with fiber optic delivery.

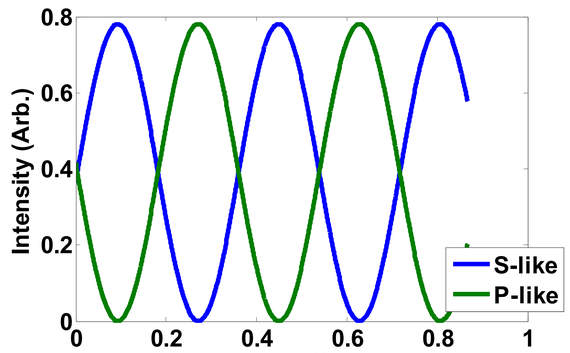
Experimental Setup:

We tested the diagnostic with a standard gas gun experimental setup. The sample in this case was a gold coating on a BK7(glass) substrate.



Window Birefringence:

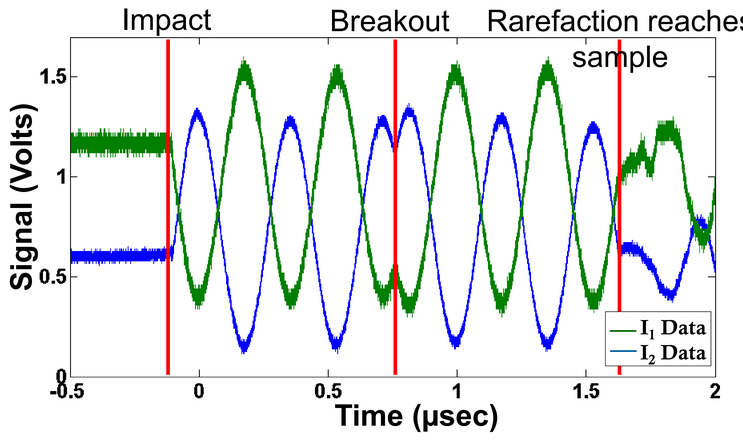
In anticipation of potential birefringence we included the capability to handle birefringence in our modeling and analysis of the polarization signals. Below is an example signal modeled with a totally birefringent shocked window – which we expect to have in this experiment.



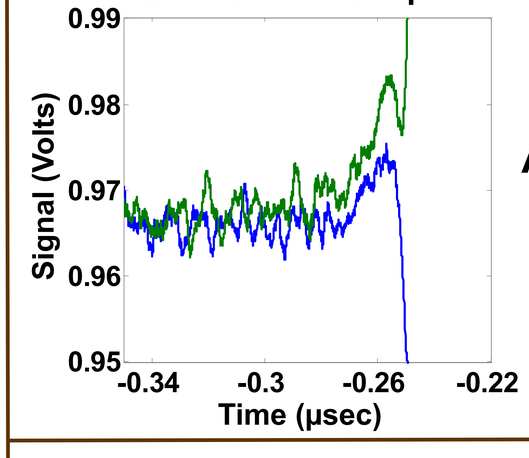
Results:

Our experimental data resembles the modeled expected results, even showing a clear sign of the window birefringence being "erased" by the rarefaction wave after breakout.

Looking at initial impact, we see indication of a change in the gold dielectric.

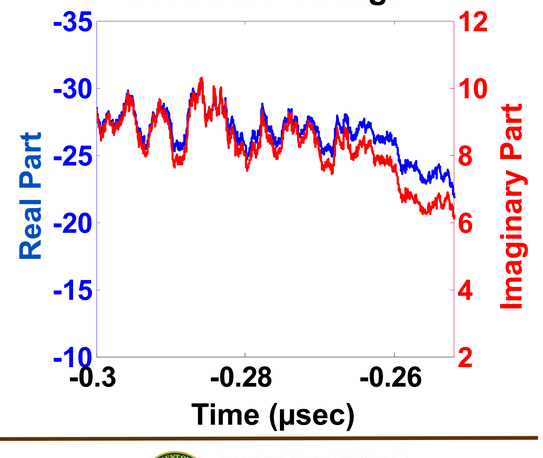


Data at Shock Impact



Analyze:

Dielectric Change



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