Diamond Radiator Thinning and Mounting

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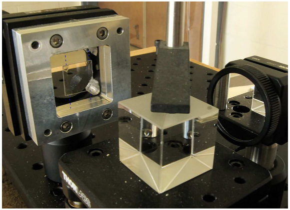
Outline

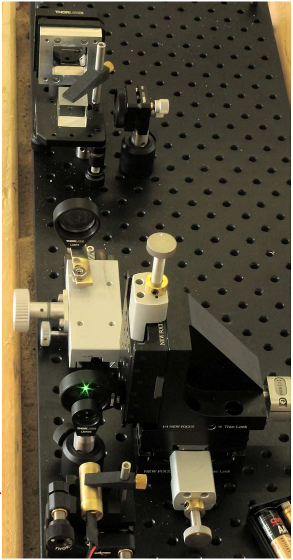
Michelson Interferometer

An optical setup being developed for measuring a diamond's shape and stability on mount.

Pinhole provides a filter and attenuator.

Camera mounted separately for freedom of zoom/focus





Measuring Oscillation

A sensitive setup is needed to measure the mechanical stability of a mounted diamond.

-another use of the Michelson Interferometer! assembled for thin diamond shape analysis

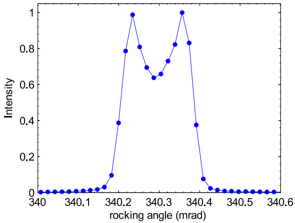


Figure: May CHESS run showed: vibration on the wires is a serious concern.

Possible techniques:

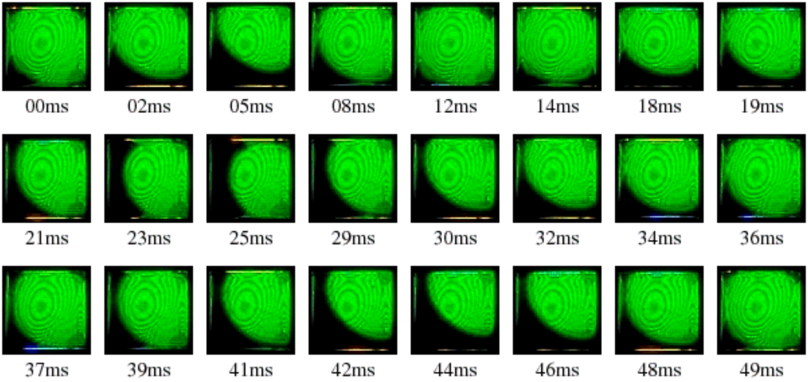
- measurement of phase difference (with the reference beam) as a function of time for different points on the diamond.
- directly measure reflection of beam from diamond using sensitive camera optics

Predicted rocking frequencies occurring at CHESS: $200\,\mathrm{Hz}$

- an optical **readout challenge**.

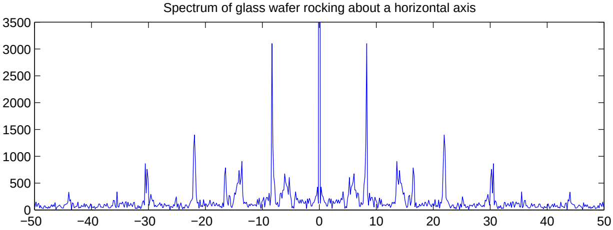
Measuring Oscillation: Angle Amplification

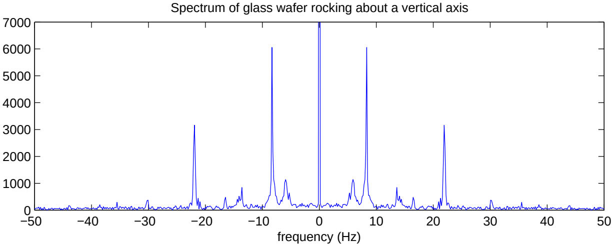
Oscillation of a glass wafer was recorded with a 1200fps camera (Casio EX-F1 - a consumer device!)



Rocking Frequency Analysis

Preliminary data: rocking spectra from high-rate video.





Upcoming Work on the Michelson Interferometer

Work ahead on diamond-mounting studies:

1. Calibrate the setup: angular sensitivity of the camera is not yet known
2. Measure the frequencies/amplitudes of the oscillation modes
3. Attempt to decrease the rocking amplitude by shifting frequencies up (e.g. higher tension, more wires etc.)

In the long term:

- If using laser ablation: try rigid clamping on thick diamond frame (BNL's technique) and measure stability
- Surface shape diagnostics of newly-thinned diamonds using 3-wave interference pattern analysis

Heat Load

The maximum beam current of $3\,\mu\mathrm{A}$ presents a significant heat load on the diamond.

This condition puts a strict design constraint on mounting.

Assuming the wire-mounting approach, few adhesives retain their properties at these temperatures.

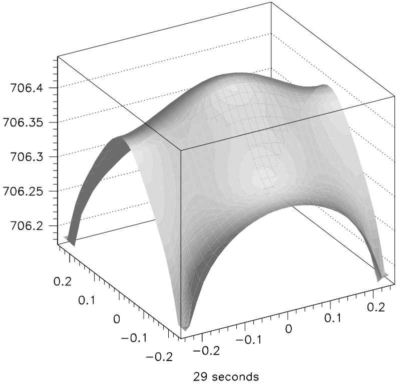


Figure: Steady-state temperature (K) profile. $18\,\mu\mathrm{m}$ tungsten wire, $8\,\mathrm{mm}$-long on four corners assumed. Note the excellent conductivity across the surface.

Heat Load: Discussion

The heating model includes Stefan-Boltzmann radiation, conduction along the diamond surface and tungsten wires of constant conductivity attached to mount at ambient temperature.

Prospects:

- more detailed treatment of wires (conductivity is really locally temperature-dependent) is not likely to change the picture significantly
- tweaking the wire length and composition within the constraints set by the minimal distance to frame and vibration considerations described above may yield some improvement
- addition of wires along the other edges can also help
- find a ceramic or epoxy robust at these temperatures, within the constraint of being able to cure without stressing the diamond
- simply clamp on frame, if thinning by ablation

Excimer Laser

Laser ablation is currently the most attractive approach to diamond thinning. Doing this inexpensively in-house would be optimal.

An old $248\,\mathrm{nm}$ excimer laser offered by a local AMO group. Condition:

- Fully functional
  when last used - 10 years ago
- System was
  properly flushed upon decommission:
  no apparent degradation
- Concerns remain
  about some possible absorbed flourine and unused vacuum pumps

Plumbing Infrastructure

Figure: Another unused excimer laser system we may be given permission to use for parts.

appropriate plumbing exists for testing the system in its place

space has been offered in another lab with available gas connections

Work Ahead

Plan of action:

- Tend to the vacuum system: replace oil in diffusion pump, test for serious leaks at moderately low pressure ($\sim 10^{-6}\,\mathrm{Torr}$)
- Test the RF generator (most expensive/hard to replace!)
  - Procure a bottle of pure Ar gas
  - Flush the tube, turn it on and test output power
  - In case of problems, another group has a system out of commission and may allow us to salvage pieces.

Barring major repair: expected online by end of 2009 with $2-3k
Long-term operating goals:

- Switch optics to $192\,\mathrm{nm}$
- Get mixture of Ar-F, eventually procure a gas mixing system)
- Ensure reliable pulse train and consistent power output ($\pm 5\,\%$)