Quantifying Surface Parallelism of Thin Glass Slide Using Interferometry

Nandita Mittal,Dinesh,Avanti,Kuldeep

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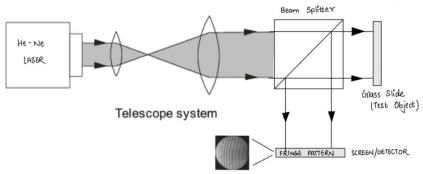
Aim

In this experiment, we have to

- determine how deviated from being parallel the two opposite surfaces of a thin rectangular glass slides individually are by means of an interferometer.
- observing the interference pattern of the same two glass slides held together at an angle, and performing computerised fourier transform on the pattern to characterise the parallelness of each slide's surfaces and cross-verify the data.

Method

- Align the laser and set up the table as shown in the schematic diagram(Figure 1).
- Adjust the glass slide in order to get a well defined fringe pattern(as in figure 2).
- Take the intensity readings of the fringe pattern using a multimeter.
- Repeat the same for two different glass slides.

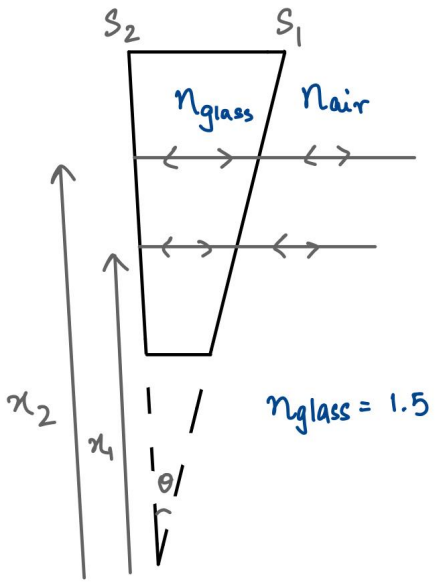


Theory

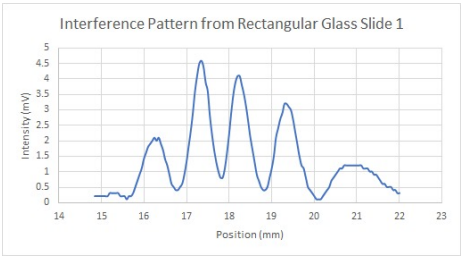
Assuming normal incidence on both surface, $\theta \to 0$.
Reflection from S_1 and S_2 interfere to form fringes.
For consecutive minima, path difference $= 2n \tan\theta(\Delta x) = \lambda$
$\implies \theta \approx \tan\theta = \dfrac{\lambda}{2n(\Delta x)}$

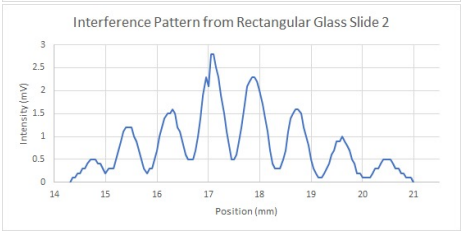
For the 2 rectangular slides held together at an angle θ_3.
Intensity is a linear function of $\cos(\theta_1 \mathrm{x} + c_1)$, $\cos(\theta_2 \mathrm{x} + c_2)$, $\cos(\theta_3 \mathrm{x} + c_3)$, where
θ_1 = angle between opposite surfaces of rectangular slide 1
θ_2 = angle between opposite surfaces of rectangular slide 2

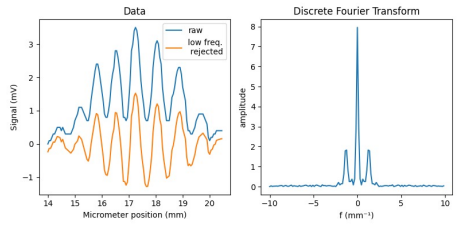
$\therefore$ Fourier transform of intensity as a function of position should yield 3 primary frequencies.



Observation and Analysis







Calculation

For rectangular slab 1, minimas at 16.8 mm, 17.8 mm , 18.8 mm , 20.1 mm.
For rectangular slab 2, minimas at 15 mm, 15.8 mm , 16.65 mm , 17.5 mm , 18.35 mm , 19.2 mm , 20.07 mm.
Using the formulas mentioned above
average of angle between opposite surfaces for slab 1 = $1.1 * 10^-2$ degrees
average of angle between opposite surfaces for slab 2 = $1.4 * 10^-2$ degrees

Error Analysis

Standard deviation for slab 1 = $1.6 * 10^-3$ degrees
Standard deviation for slab 2 = $4.1 * 10^-4$ degrees

Result

1. We can see that when angle increases from first case to second case, the number of fringes,formed for the same laser beam width , increases.

2. The Fourier transform of the intensity graph of the two rectangular slabs held at an angle yields one primary frequency contrary to the three expected, possibly due to our limitation of being unable to suitably orient the slides owing to their small thickness.