VE438: Advanced Lasers and Optics Laboratory

Laboratory manual
Lab 2: Interference[1]

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1 Suggested Reading Assignment

Optics (Hecht) Ch 7, 9, 12

2 Pre-lab Questions

1. Sketch and show what a standing wave is. Explain "constructive interference" and "destructive interference".
2. Calculate the optical path difference for a green light(500nm) passing through 100m of air/water ($n = 1.3$).
3. Describe the role of "coherence" in Young's experiment. If sunlight is used in Young's experiment instead of laser, what pattern will be observed?
4. Design an anti-reflection coating for air/glass($n = 1.5$) interface. Explain how it works.
5. Sketch the setup of Michelson interferometer and Mach-Zehnder interferometer. Explain the vertical fringes at the interferometer output.

3 Procedure

NOTICE:

- Pay attention to all lab safety instructions. Lasers used in the lab might hurt your eyes if you look into the beam directly.
- Equipment used in optics experiments such as mirrors and prisms are very fragile thus special operating rules need to be followed. Your grade for in-lab operation will be deducted for improper operations.
- Make sure the checklist below is clear before leaving the lab:
  - ☐ The experimental setup has been shown to the TA;
  - ☐ The data sheet has been checked and signed by the TA;
  - ☐ The equipment has been restored;
- TA will give a question to one of the group members to check your understanding on lab content. Grade for in-lab operation and the question will be shared among the whole group.

PART A: Mach-Zehnder Interferometer

1. Mount BS1, M1, M2, BS2, and Lens1.
2. Align BS1, M1, M2, BS2, and Lens1 according to this order. A square shape light path is recommended in order to get the fundamental mode more easily.
3. Let the light spots overlap after BS2. You are supposed to see the high order mode of the interference pattern.
4. Use Lens1 to enlarge the light spot. Adjust M1, M2, and BS2 to get the fundamental mode.
5. Use a dryer to disturb one of the arm, and see what the interference pattern will be like.

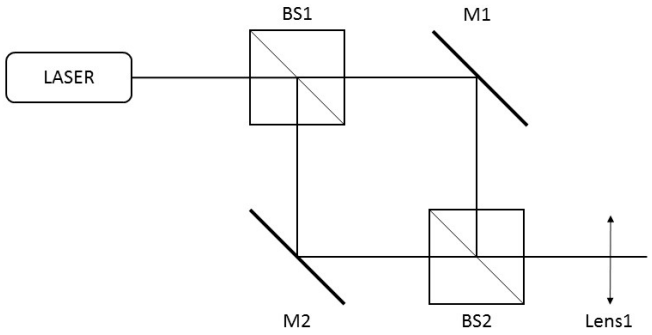

Figure 3.1. Scheme for a Mach-Zehnder interferometer

4 Post-lab Questions

1. Find out the typical linewidth of a He-Ne laser and calculate the corresponding coherence length. Why the coherence length cannot be measured directly in lab? What's your strategy to solve the problem?
2. Describe several interference patterns you observed in Lab 2 and explain.
3. Describe your observation after disturb one of arm of the interferometer with a hot air-dryer. Explain what you observed.
4. Design a device to measure the refractive index of a glass slide (with specified thickness) based on Michelson interferometer.