Reflection technique for measuring poled PMMA’s electro-optic coefficient

Hugo BRUDI, Roger TIPTON, Dianhao HOU, Darrick HAY, Dr BHETHANABOTLA, Department of Materials science, University Of South Florida

Introduction and Motivation

An electro-optic material is a material for which, when a steady electric field is applied, the refractive index evolve. It implies that when you change the value of the electric field, it change the effect of the material on light crossing it. In order to measure the electro-optic coefficient of polymers, many different methods exist. Here is studied a really easier to set up technique to measure the electro-optic coefficient than the ones existing yet.

Materials and experimentation

Sample preparation

- First step is to synthesize a solution of adapted PMMA:
  - 500 mg PMMA
  - 37.5 mg of Disperse Red 1 (DR1)
  - 20 ml of Dichloromethane
- Deposit the liquid on a Indium Tin Oxyde (ITO) glass
- Spin coat the ITO glass in order to spread and dry the solution on the glass
- Deposition of a thin aluminium coating on the glass side

Poling

Poling is a needed step to the preparation of the sample for the reflection technique. The effect of the poling process is to make the polymer chains that compose the PMMA, evolve from a disordered state to straight polymer chains. This allows the passage of the laser beam during the reflection technique.
- First step is to associate conductive wire with the sample : one on the ITO part and the other on the aluminium part.
- Immerse the sample into an oil bath to 120°C
- Turn on voltage source and ramp up to 30V during 15 min. During this step, the electrons move from ITO part to aluminium part that explain the tendency to straighten up
- Stop the hot plate and wait that the temperature shut down to 20°C before stopping the voltage source

Reflection technique

Once the poling finished, the sample is ready to be used for the reflection technique.
- A [characteristics] laser beam is used as an input
- Collimated light is sent through a half-wave plate in order to select an input polarization state
- Beam is reflected on the aluminium side of the sample with a 45° angle
- The sample is connected to a power supply controlled by a computer which made it vary incrementally
- Reflected beam is collected by a Thor Labs Polarimeter which is composed of a rotating quarter wave plate and which measure the polarization state
- A voltage is applied on the sample while data like Azimuthal angle, Elliptical angle and stokes parameters are collected

Results

The result for the first sample is given on the figure 8. For this analyze of our sample, we can estimated a electro optic coefficient value around -70.25°/V but it does not give an accurate result of the value as there is a lot of noise on the result. We can not compare this value with already existing values as this value depends on the polarisation density issued from the poling process. However it is noticeable that the value seems to be constant not regarding from the voltage evolution.

Conclusion-Future work

On the result part we saw that there is a lot of noise that is why it is necessary to find settings and experimental conditions to have the less noise possible and so to be more accurate in the value. During the future weeks, we will take the reflection technique again with different settings.

The other part of the future work is to use this reflection technique with a sample composed of 15% of DR1 instead of 7.5%, once we will have the best conditions for reflection technique. With these results, we can compare the value in order to know the best settings for our PMMA sample.

References

- C.C. Teng, H.T. Man, Simple reflection technique for measuring the electro-optic coefficient of poled polymers, App. Phys. Lett. 56 (18), 30 April 1990