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Characterising the temperature dependent spectra of polyethylene for terahertz optics

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Polyethylene is a highly transparent material in the terahertz (THz) region ($1\text{-}200\text{ cm}^{-1}$). This makes it ideal for lenses and windows, especially for cryostats. It is also often used as a binding medium in sample pellets to dilute trace amounts of optically thick samples.

One caveat for this extremely useful material, however, is an absorption at 73 cm^{-1} , often overlooked when utilising polyethylene for terahertz optics. This mode was first studied during the 1960's [1,2] but has sparsely been mentioned in scientific literature since, most recently in 2019, being described as “elusive” [3].

To determine the effects of this absorption on terahertz optics we have quantified the intensity and frequency of this mode from 6-300 K for different sample thicknesses on the THz beamline at the Australian Synchrotron. We have observed a large redshift of 6.7 cm^{-1} ($79.9\text{-}73.2\text{ cm}^{-1}$) with heating over this temperature range, as well as significant reductions in the peak intensity. These results indicate that for thin samples ($<2\text{ mm}$) of polyethylene this mode is negligible at room temperature, however, at cryogenic temperatures this mode causes a notable drop in transmission, even for samples as thin as 0.5 mm. This warrants caution, especially when selecting cryostat windows and observing weak features near this mode.

[1] R. V. McKnight et al., “Far-infrared spectrum of polyethylene, and quartz-crystal plates”, J. Opt. Soc. Am., 54(1), 132-133, 1964.

[2] S. Krimm et al., “Assignment of the 71-cm^{-1} band in polyethylene”, J. Chem. Phys., 42(11), 4059-4060, 1965.

[3] K. Zhou et al., “Transmittance of high-density polyethylene from 0.1 THz to 15 THz”, Proc. SPIE 11196, Infrared, Millimeter-Wave, and Terahertz Technologies VI, 2019.

Level of Expertise

Student

Presenter Gender

Man

Pronouns

He/Him

Which facility did you use for your research

Australian Synchrotron

Students Only - Are you interested in AINSE student funding

Yes

Do you wish to take part in the Student Poster Slam

No

Condition of submission

Yes

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