$CuInP_2S_6$: a 2D Ferroelectric with giant UV birefringence and anomalous refractive index modulation

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Due to the increasing need for highly efficient, tuneable, and high-speed electro-optic devices for next generation telecommunications, sensing and quantum technologies, there has been a surge of interest in 2D Ferroelectrics. These are materials which have internal electric fields below certain temperatures, and show non-linear and tuneable optical and electronic properties with the potential to revolutionize those technologies. For instance, materials with large birefringence, particularly within the visible-ultraviolet range, are essential for light polarization manipulation, ultraviolet communications, and lithography, making them highly desired in many fields. In this project, we discovered an unprecedented anomalous thickness-dependent change in refractive index, as large as δn ~ 23.2%, in the 2D ferrielectric CuInP2S6. Moreover, we demonstrate that CuInP2S6 presents giant birefringence, especially within the blue-ultraviolet regime, where it exhibits, to the best of our knowledge, the largest value of any known material. Backed by computational calculations, we propose a complex and thickness-dependent interplay between polarization, light and ion mobility as an explanation for the anomalous behaviour of CIPS with thickness, which paves the way for a paradigm shift in future electro-optics and photonics based on the 2D ferroelectric materials [1].

References

[1] H. El Mrabet Haje, R. J. van der Kolk, T. M. Kyrk, S. Grytsiuk, M. Rösner, and M. N. Ali, " Anomalous Refractive Index Modulation and Giant Birefringence in 2D Ferrielectric $CuInP_2S_6$." *Adv. Optical Mater.* 13, no. 35 (2025): e02291.

[2]

Figures

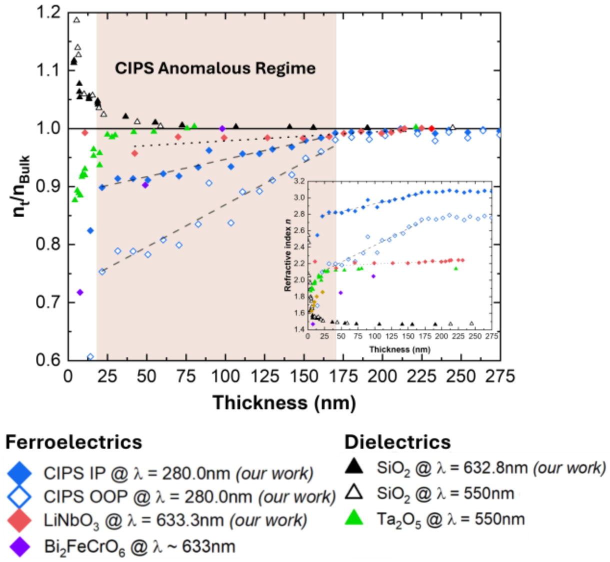

Figure 1: Refractive index thickness dependence comparison CIPS and other materials. n_t/n_{Bulk} represents the ratio between the refractive index at a certain thickness (n_t) and the refractive index at the maximum thickness (n_{Bulk}). The inset shows the raw refractive index thickness dependencies.

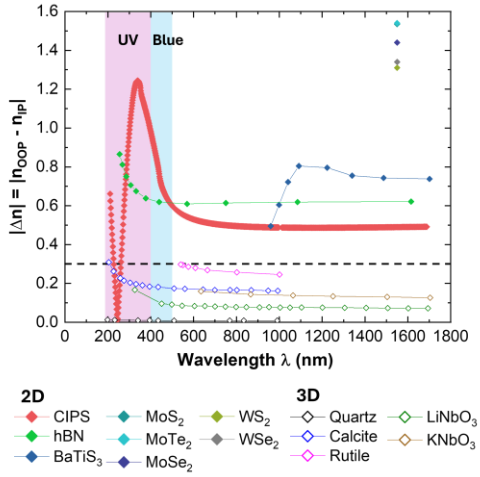

Figure 2: Birefringence |Δn| comparison between CIPS at t ~ 22 nm and other materials.