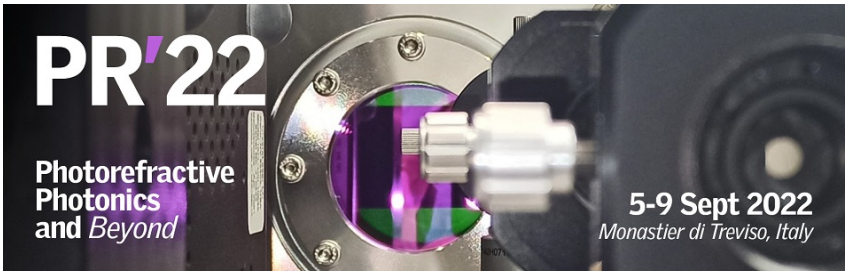

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Influence of substrate stress on the electro-optic effect in polycrystalline bismuth ferrite films

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With their linear electro-optic effect, i.e. the linear change in the refractive index under an electric field, complex ferroelectric oxides are an ideal candidate to control the propagation of light in the field of integrated optics.

The research focused on the integration of thin ferroelectric films for electro-optic applications is concentrated on a few promising systems such as barium titanate, with high electro-optic coefficients but strong temperature dependence, or lead zirconate titanate, which is more stable but subject to environmental legislation restrictions. An interesting alternative is bismuth ferrite (BiFeO₃), often used in photoferroelectric investigations. The high Curie temperature of BiFeO₃ (1100 K), its high birefringence together with its lead-free nature makes bismuth ferrite a candidate for electro-optic applications.

In this study, we focus on the effect of mechanical stress on the electro-optic properties of solution-deposited polycrystalline BiFeO₃ thin films. Low-leakage polycrystalline bismuth ferrite thin films were fabricated on c-cut sapphire, fused silica, and magnesium oxide substrates to induce different degrees of stress in the films. The electro-optic coefficients were measured using the Teng-Man technique. Two different electrode configurations were used: metal-insulator-metal (MIM) and interdigitated electrode configuration (IDE).

The films show stress values ranging from +0.93 GPa (tensile stress) on fused silica to -0.54 GPa (compressive stress) on MgO. High tensile stress enhances the in-plane polarization, enhancing the Pockels coefficient in interdigitated electrode geometry. These results give guidelines for the design and geometry of thin film-based electro-optic devices.

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