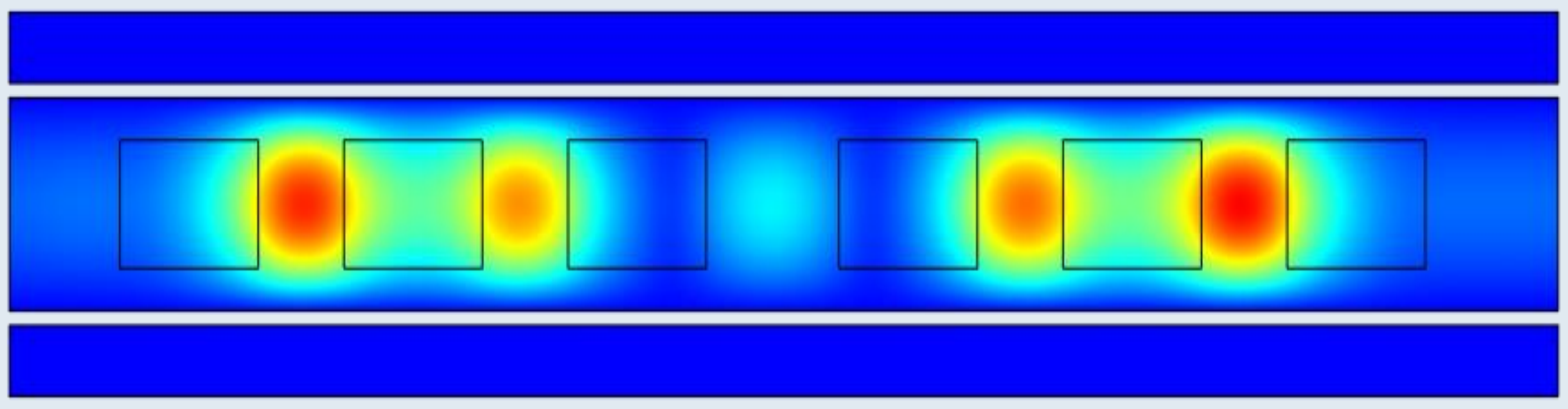

Wavelength and Bit-rate Tunable Silicon - Organic Hybrid Modulator Using Commercially Available HLD

This work discusses the design of a Si waveguide modulator incorporating a set of 1D Bragg filters using 3 Si-HLD bilayers with a central Si defect region for low voltage tunable Wavelength and variable Bit-rate Modulation.

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Abstract

In the rapidly advancing field of on-chip photonic modulators, the choice of materials plays a crucial role in achieving high-performance optical modulation. Traditional approaches have utilized nonlinear optical (NLO) material stacks like $LiNbO_3$ or $BaTiO_3$ on silicon substrates or relied on current injection across silicon waveguides to induce phase changes for optical modulation. However, these methods have photostability, thermal stability, and fixed wavelength operation limitations. To address these challenges, this work explores the integration of a novel chromophore, HLD(Nonlinear Materials Corporation) into silicon-based photonic devices. HLD is reported to give a large Pockel effect with a high r33 of 290pm/V, a Tg of 1500^0C with a refractive index of 1.83 and it can be spin-coated or grown in situ from powder (without host polymer) and the process will be CMOS compatible. The voltage range used for tuning in the C & L band is 0.1 to 1 V. This design has a maximum wavelength tuning of over 690nm within 1 Volt.

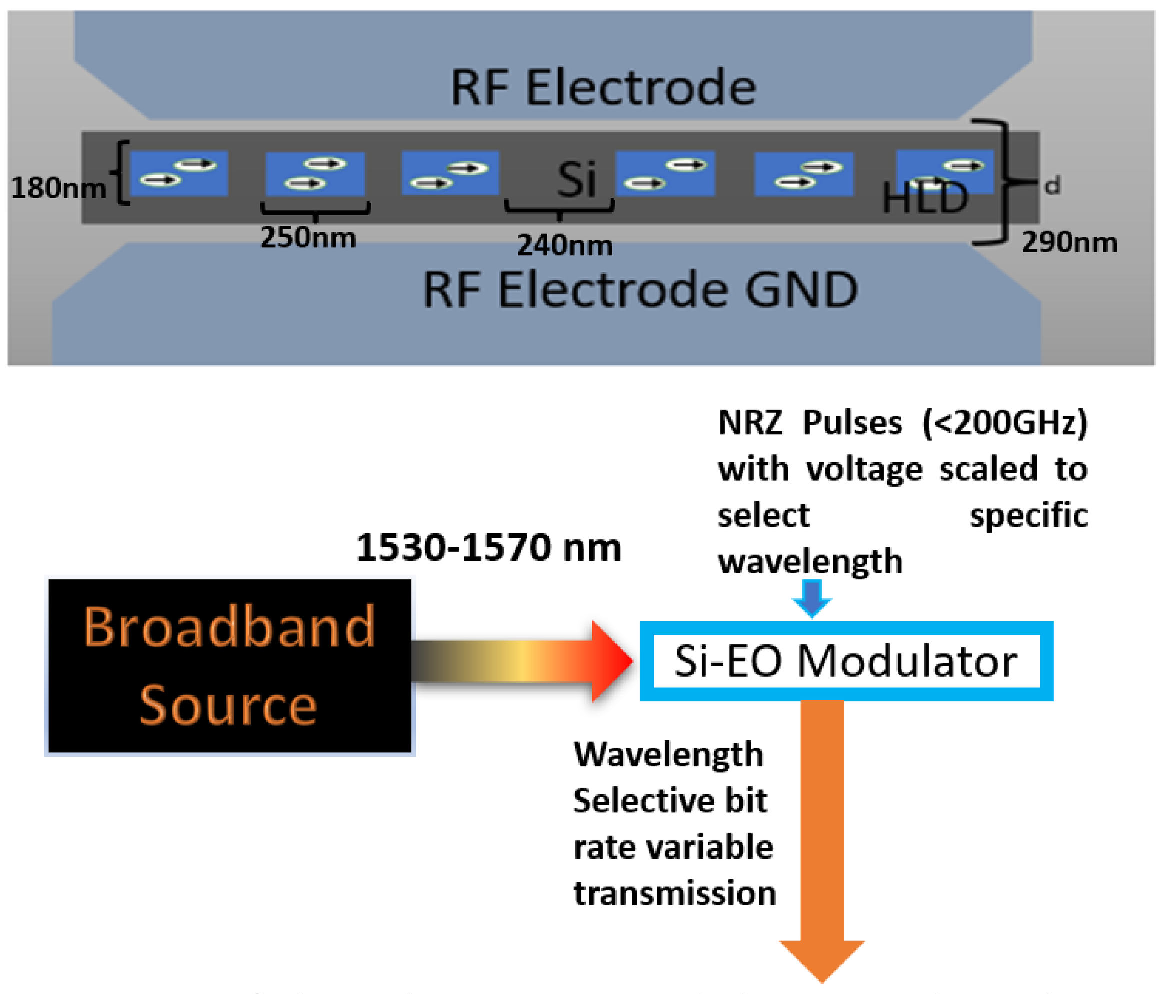

Figure 1 : Design of the Silicon EO Modulator and application

Methodology

On application of voltage to the electrodes on either side of the waveguide, the Pockels effect-induced index change of the HLD in the Bragg filter will selectively transmit one wavelength in the C band and one wavelength in the L band. The Refractive index change in the EO material is governed by Equation,

$$\Delta n_{HLD} = -\frac{n_{HLD}^3 \gamma^{33} f^3 V}{2d}$$

Where, Δn_{HLD} is the change in refractive index of HLD , γ^{33} is the EO Coefficient (290 pm/V), V is the applied voltage, d is the separation between electrode, f is the field factor (6.1).

Results

COMSOL Multiphysics software is used to design a silicon HLD waveguide filter. Figure 2 Shows the transmission spectrum for different values of applied voltage and wavelengths in the C(Line graph) & L(Dotted graph) bands. Here, we'll get tuning in both the C and L bands for a single voltage setting. There will be tuning in the C band if the source only covers the C band. One C band and one L band will be transmitted simultaneously if the source is a full broadband source. The desired wavelength of transmission can be changed by applying the proper voltage to the electrodes.

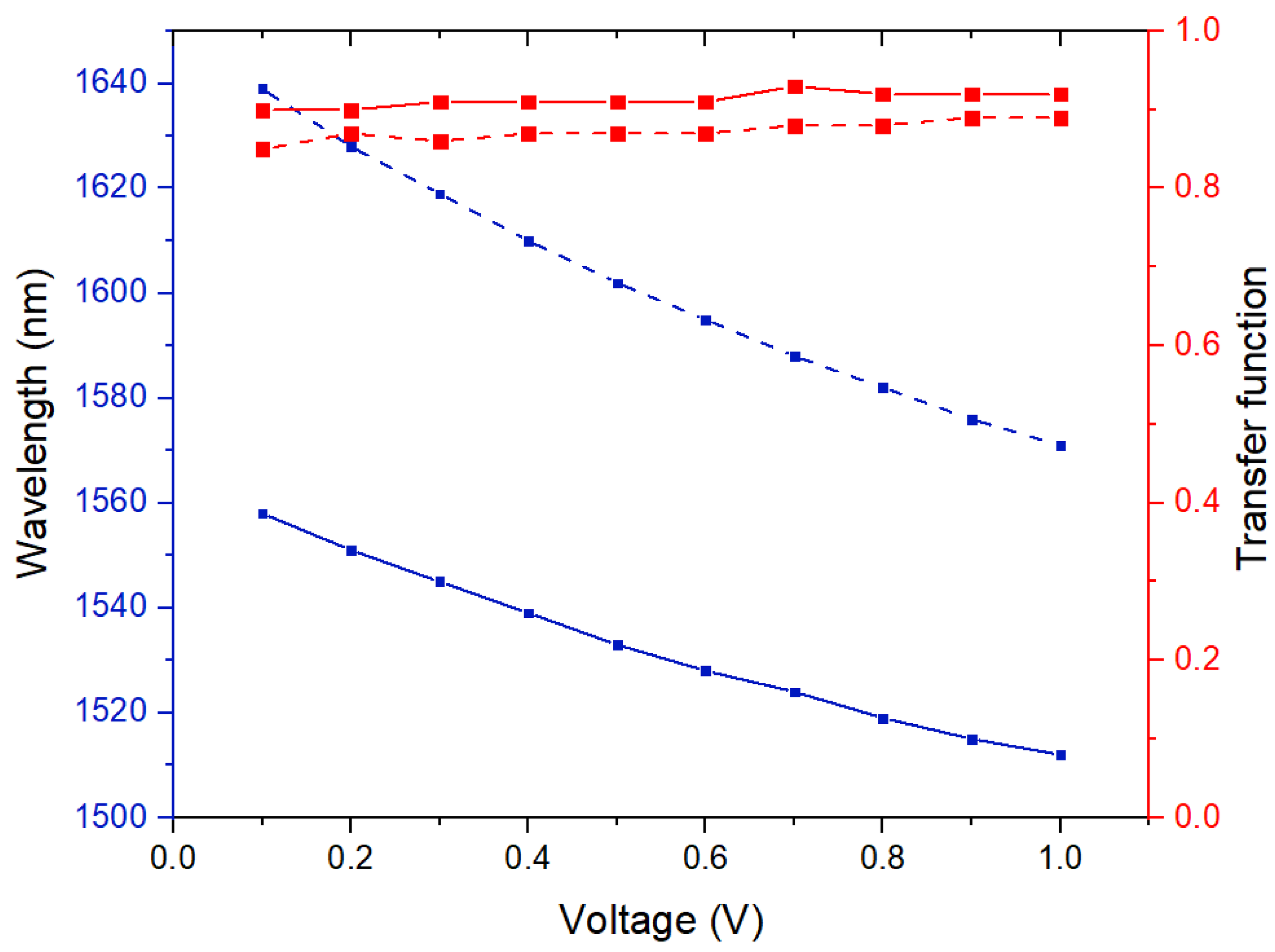

Figure 2: Voltage tuning curve and transfer function for Si-EO Wavelength selective waveguide

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