

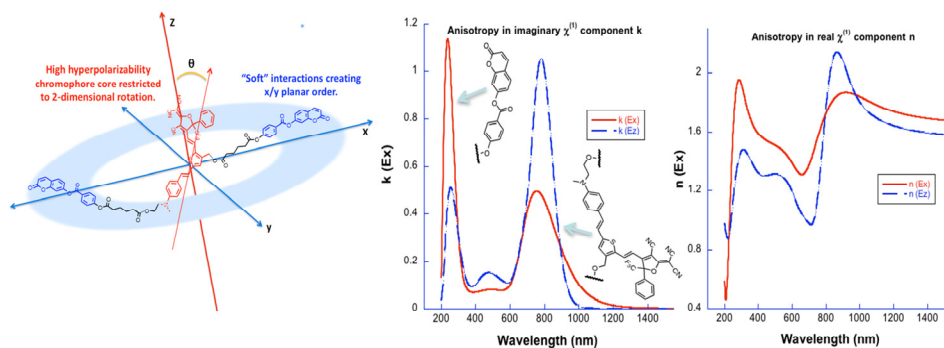


## Thrust on Organic Electro-Optic and All-Optical Materials and Devices

JRS1



**ACHIEVEMENT:** Variable Angle Spectroscopic Ellipsometry (VASE) and Variable Angle Polarized Referenced Absorption Spectroscopy (VAPRAS) have been utilized to measure the poling-induced order of chromophoric components in multi-component electro-optic materials.



VASE results (shown above) permit determination of the relative orientation of the electro-optic chromophore and the LC (coumarin) mesogen and the poling-induced order of these moieties in the electro-optic material shown at the left. These results can be compared with theoretical simulation results.

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**Goals:** One of the goals of the Thrust on Organic Electro-Optic and All-Optical Materials and Devices is to develop transformative electro-optic materials and device concepts. This goal requires development of an understanding of the role played by various spatially-anisotropic inter/intramolecular interactions in defining poling-induced acentric order of chromophores necessary for electro-optic activity

**Achievements:** New techniques (VAPRAS and VASE) have been developed that permit definition of the order and relative orientations of various critical components of electro-optic materials. This data can be compared directly with the results of time-dependent density function theory (TD-DFT) and pseudo-atomistic Monte Carlo/molecular dynamics calculations to test the efficacy of new theoretical methods in predicting poling-induced order in complex (soft matter) materials. The experimental and theoretical advances achieved over the past year can be said to lead to a "first principles" prediction of electro-optic and related (e.g., dielectric permittivity) properties and as such are defining a tool set for systematic nano-engineering of soft matter electroactive materials.

**Impact:** Electro-optic activity in the range 400-500 pm/V has been achieved together with low optical loss. Materials have been used by Lumera Corporation (GigOptix) to fabricate Mach Zehnder modulators with 20 GHz bandwidth and operating with drive voltages of 0.25 V. Boeing has used hybrid organic EO/silicon photonic ring microresonator devices from the STC to demonstrate high data rate reconfigurable optical add/drop multiplexers (ROADMs) for chipscale information management on airborne platforms.

**Future Work:** Electro-optic activity will be further increased to meet requirements of many defense applications. Photo- and thermal stability will be improved to satisfy the requirements of a broader range of applications. An effort will be made to improve the total insertion optical loss of silicon photonic devices. Research will be continued to improve soft and nanoimprint lithography processing of complicated photonic circuitry with the objective of broadening applications and reducing cost.

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