

# Ultra-Large Electro-Optic Activities from Supramolecular NLO Materials

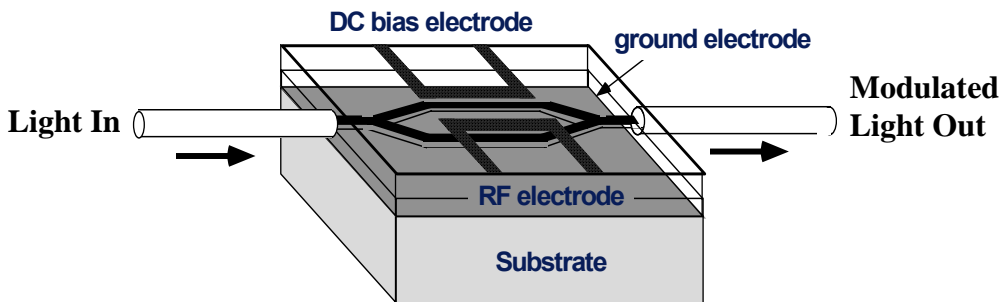
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An electro-optic device (material) permits electrical and optical signals to talk to each other. This requires a material with a voltage-controlled index of refraction (speed of light).

*Speed > 200 GHz and can potentially reach THz from organic E-O materials*

Comparison of E-O Polymers to Lithium Niobate



Material Property	E-O Polymer	LiNiO <sub>3</sub>
Bandwidth-Length Product $\Delta fL$ (GHz-cm)	350	10
Dielectric Constant ( $\epsilon$ )	2.5 - 4	28
Refractive Index (n)	1.6 - 1.7	2.2
Optical Loss (dB/cm) <sub>1.3<math>\mu</math>m</sub>	~ 1	0.2
Thermal Stability (°C)	85	90
Half Wave Voltage $V_{\pi}$ (V)	1 - 3 (~ 50 pm/V)	5 - 10
$r_{33}$ (pm/V) <sub>1.3<math>\mu</math>m</sub>	> 300	31

Refractive index change :  $\Delta n = - (n^3/2)r_{33}E$

**Criterion : Materials must possess noncentrosymmetry**

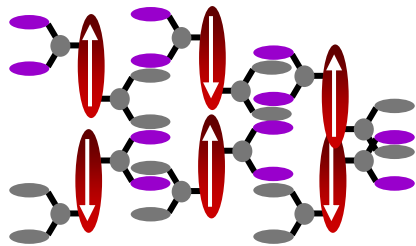


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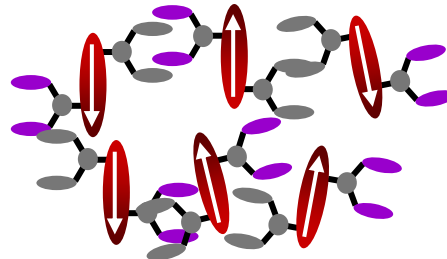


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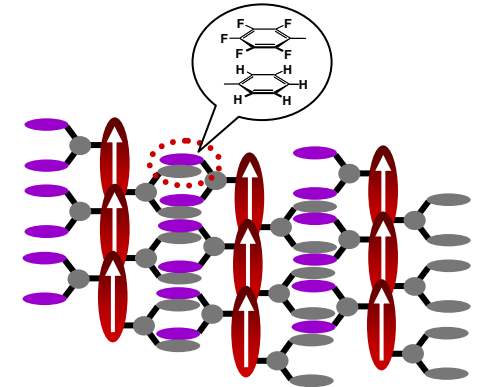
## Self-Assembled Supramolecular System



$> T_g$



Poling  $\sim T_g$   
Cool down



### First Stage

: Stable glassy solid state  
Pre-aligned structure  
Net polarizability = 0

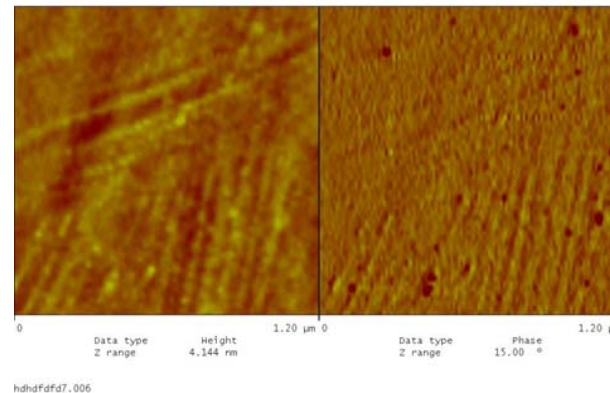
### Second Stage

: Liquid-like rubbery state  
Random structure  
Net polarizability = 0

### Third Stage

: Stable glassy solid state  
Well-aligned structure  
Net polarizability  $\neq 0$

- ♣ Excellent Processability
- ♣ Easy Chromophore Alignment
- ♣ Local Order by  $\pi$ - $\pi$  Stacking



AFM Images of Local Order

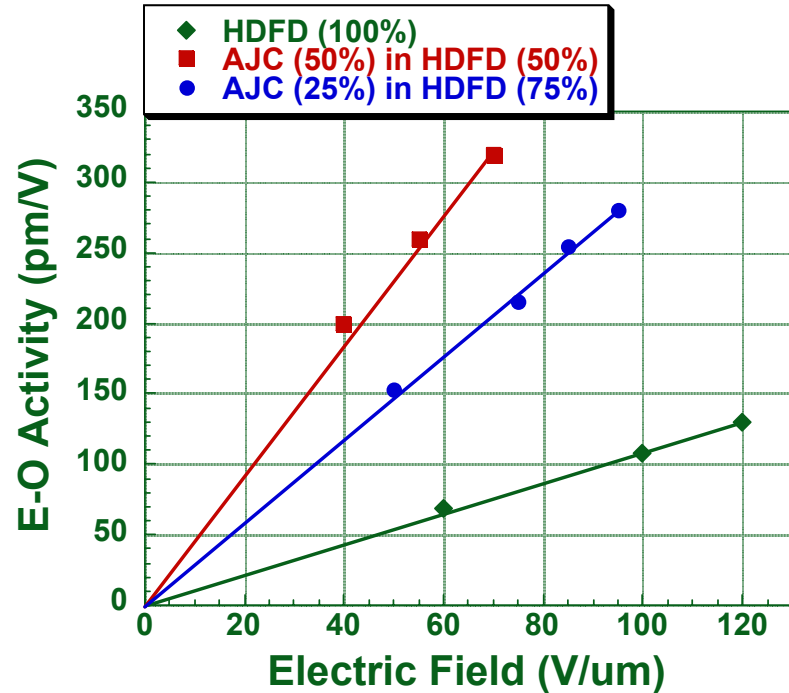
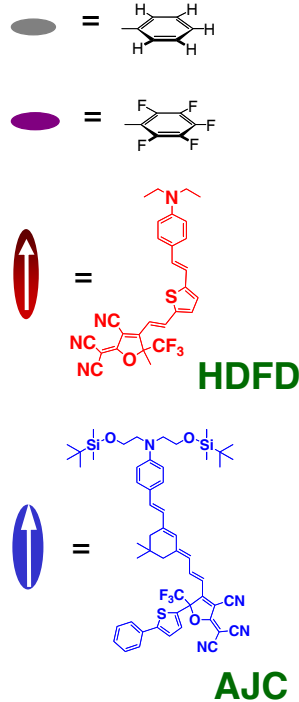
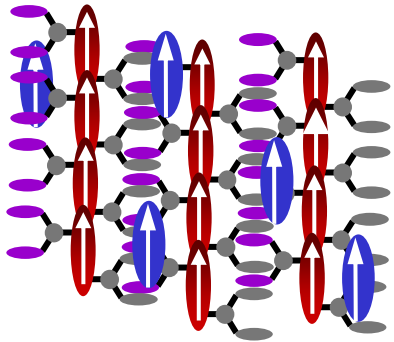


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## Blending System in Supramolecules



- ✦  $r_{33} = > 300 \text{ pm/V}$
- ✦ Temporal Stability = > 90 % (at Room Temp.)

## Next Step

- To achieve maximum  $r_{33}$
- To improve thermal Stability
- To make E-O Devices

