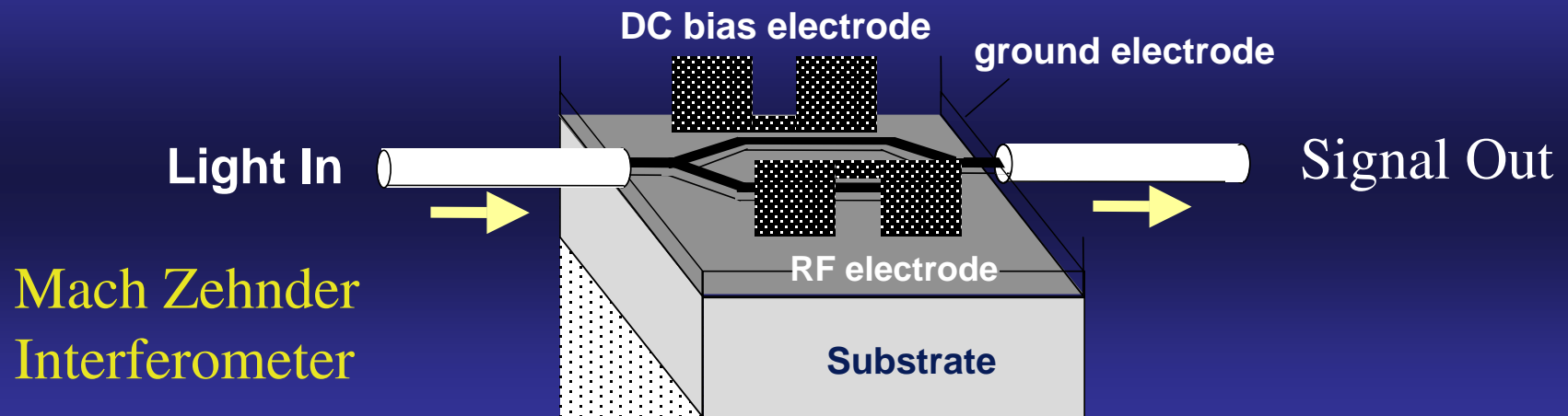


# Molecular Engineering of Organic Materials for Enhanced 2<sup>nd</sup>-order Nonlinear Optical Properties

Philip A. Sullivan, L. R. Dalton Research Group  
University of Washington CNT (dual degree)



➤ Ultra-fast electrical to optical signal transduction > 200 GHz



Mach Zehnder Interferometer

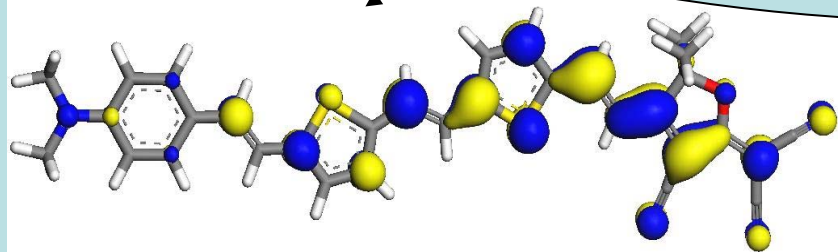
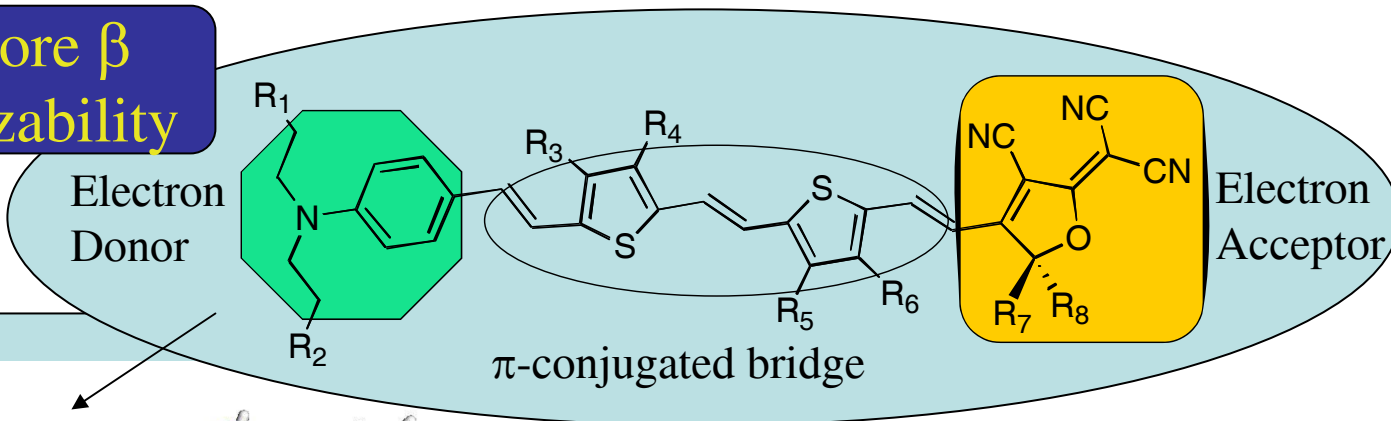


THE CENTER FOR  
NANOTECHNOLOGY

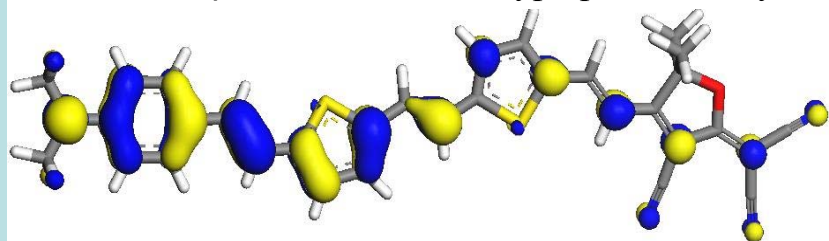


Two main parts to consider microscopic = (chromophore:  $\beta$ )  
 Macroscopic =  $\chi^{(2)}$  dependant of chromophore order

Chromophore  $\beta$   
 hyperpolarizability



$\beta$  = molecular first hyperpolarizability



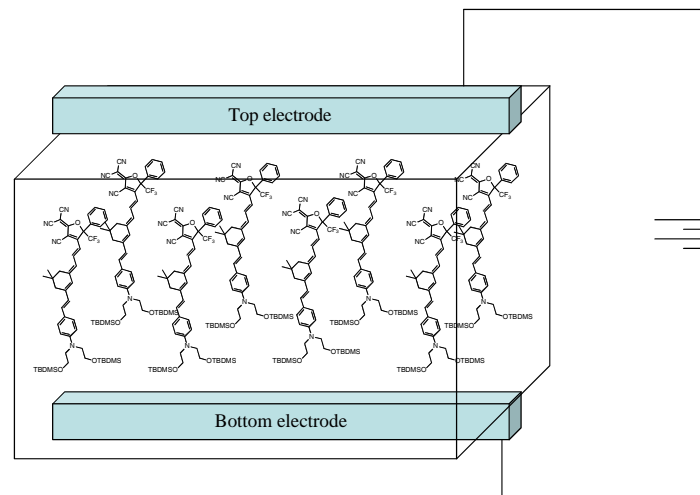
\*Kinnibrugh, Sullivan *et al.*, Submitted, 2006

Macroscopic  $\chi^{(2)}$

$$\chi^{(2)}_{zzz} = NF\beta_{zzz} \langle \cos^3 \theta \rangle$$

**E**

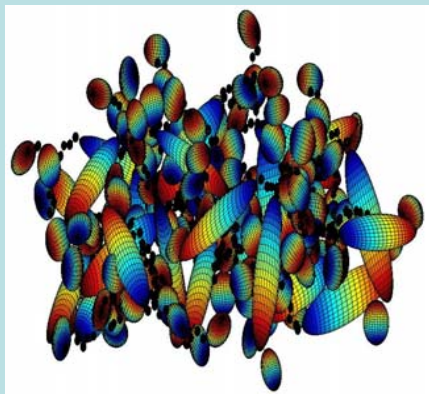
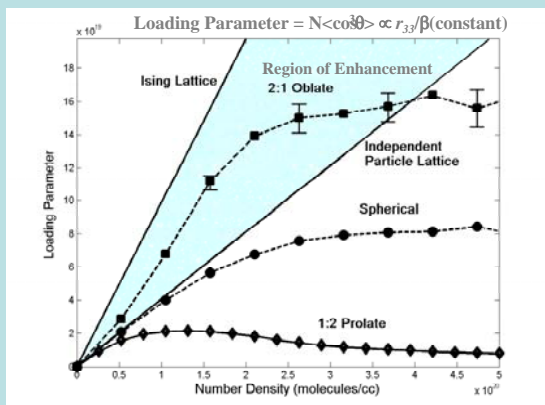
**F  
i  
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Ideal case:  $\langle \cos^3 \theta \rangle = \mu E / 5kT$

# What We Do: From theory to synthesis to device

Theory

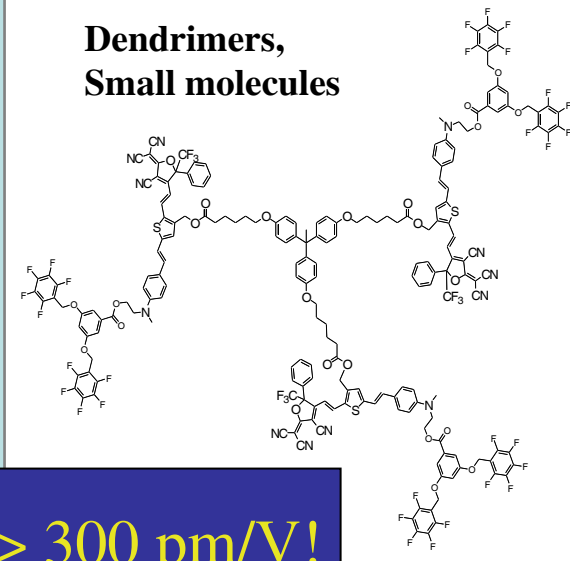


Modeling:  
Dipole-dipole,  
Shape effects

synthesis



Dendrimers,  
Small molecules



Device



Mach Zehnder

Ring Microresonator...

$r_{33} > 300 \text{ pm/V!}$

Nanostructural engineering to optimize long range molecular-scale order