

Tuning the wavelength of emission in organic semiconducting lasers by the orientation of a liquid crystalline conjugated polymer

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How do DFB lasers work?

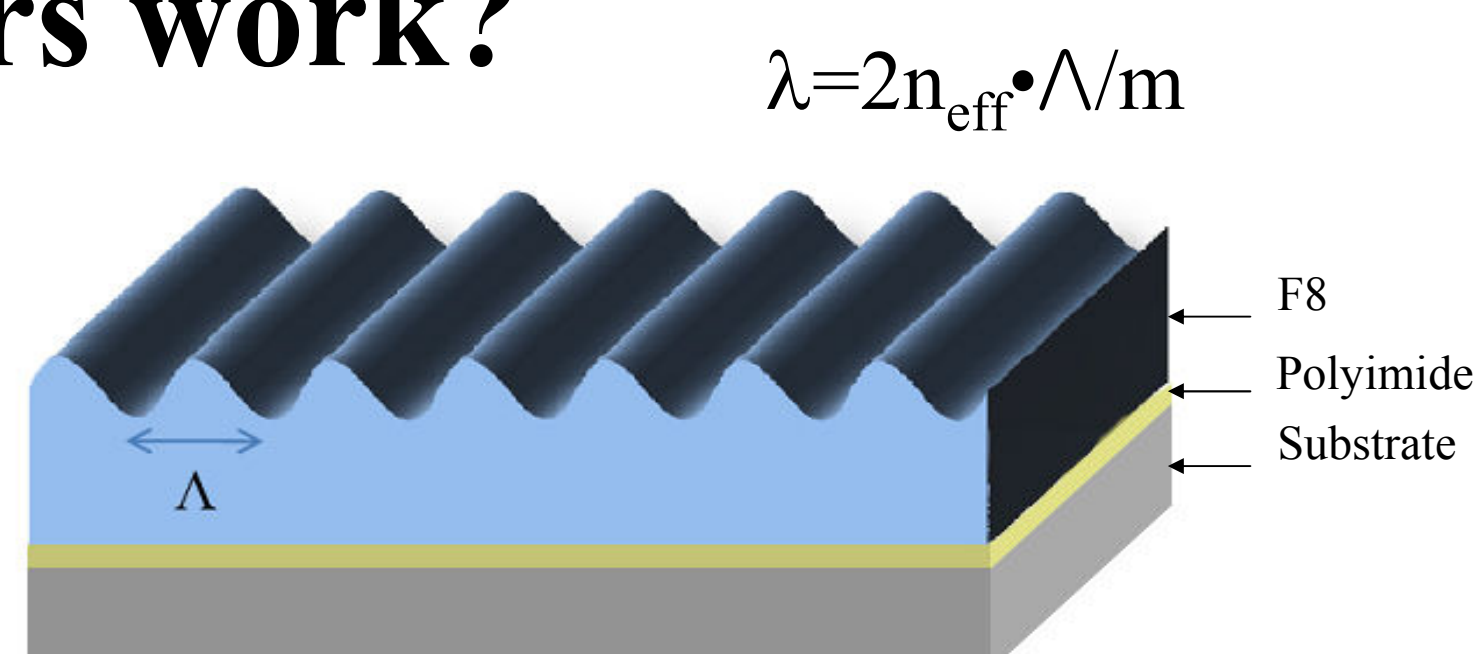
λ : Bragg wavelength,

Λ : Grating period

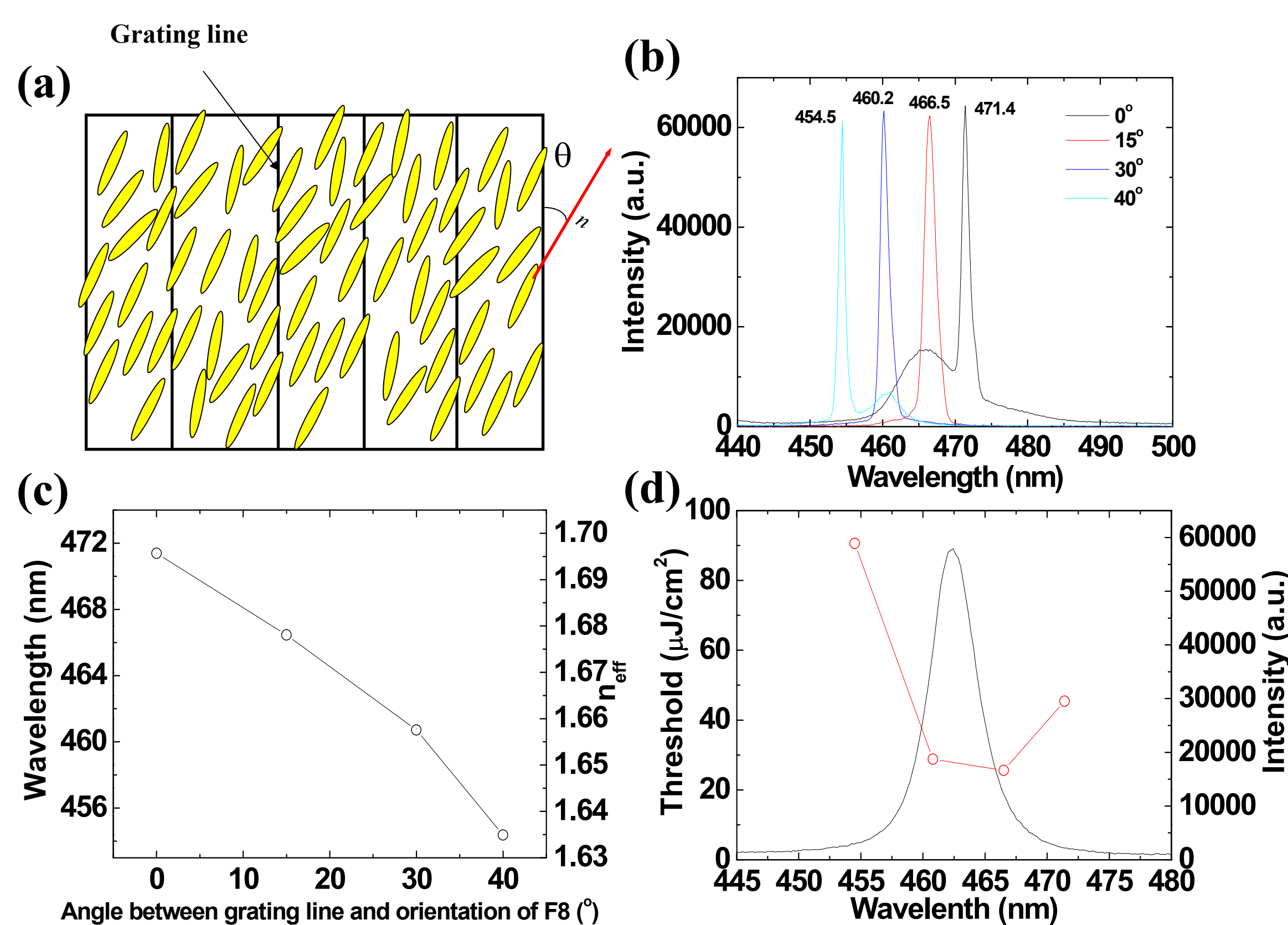
m : The Bragg order

n_{eff} : The effective refractive index of waveguide structure

- First order grating ($m=1$): band edge emission
- Second order grating ($m=2$): Surface emission



Tunable lasers

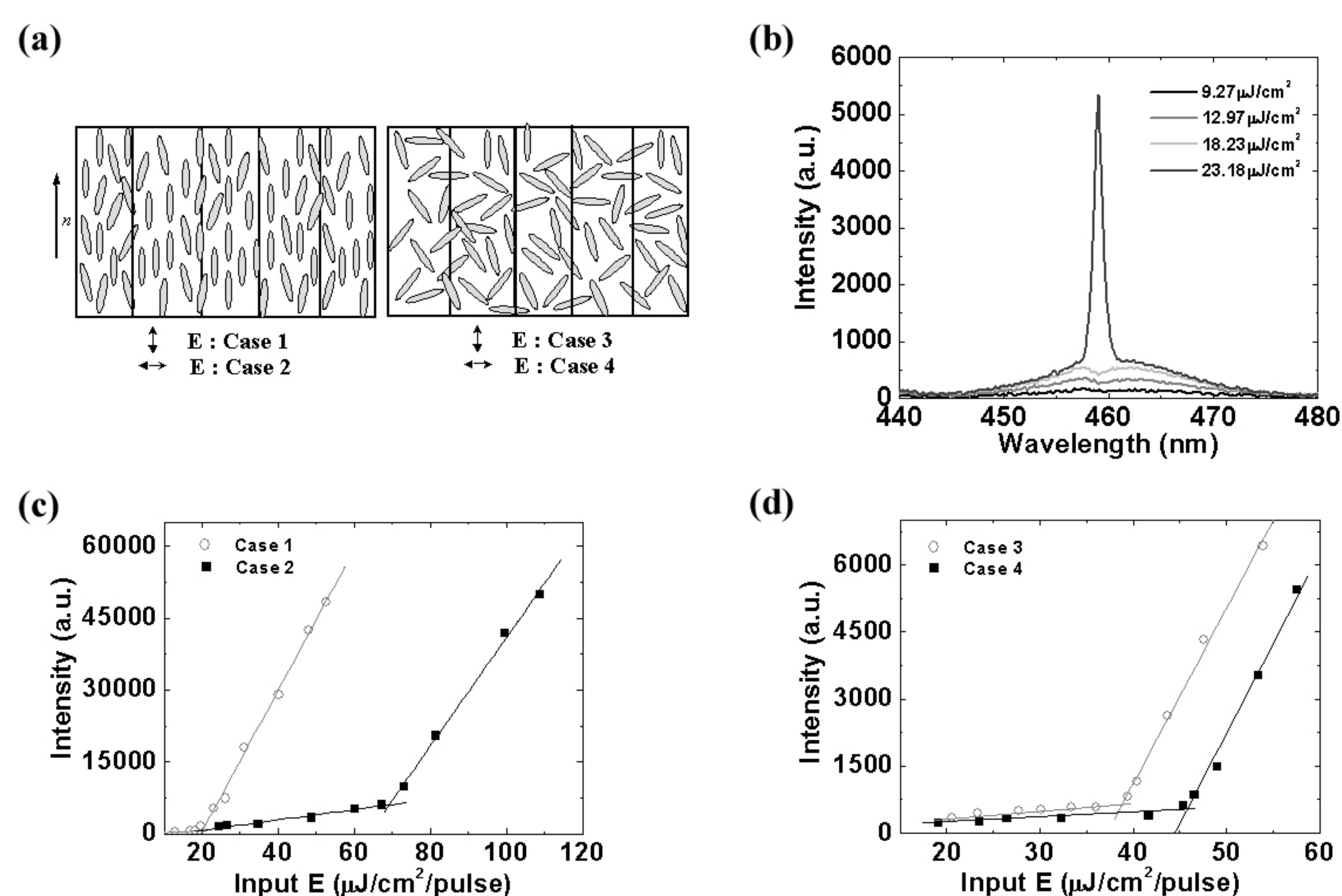


(Above) (a) Schematic of tunable DFB F8 laser sample cell. (b) Lasing spectra measured for the anisotropic F8 laser sample cell with different angles between grating line and the orientation of F8. (c) Lasing wavelengths and effective refractive index of the anisotropic F8 laser sample cell as a function of angles between grating line and the orientation of F8. (d) Threshold energy as a function of laser wavelength for the anisotropic F8 laser sample cell with different angles between grating line and the orientation of F8.

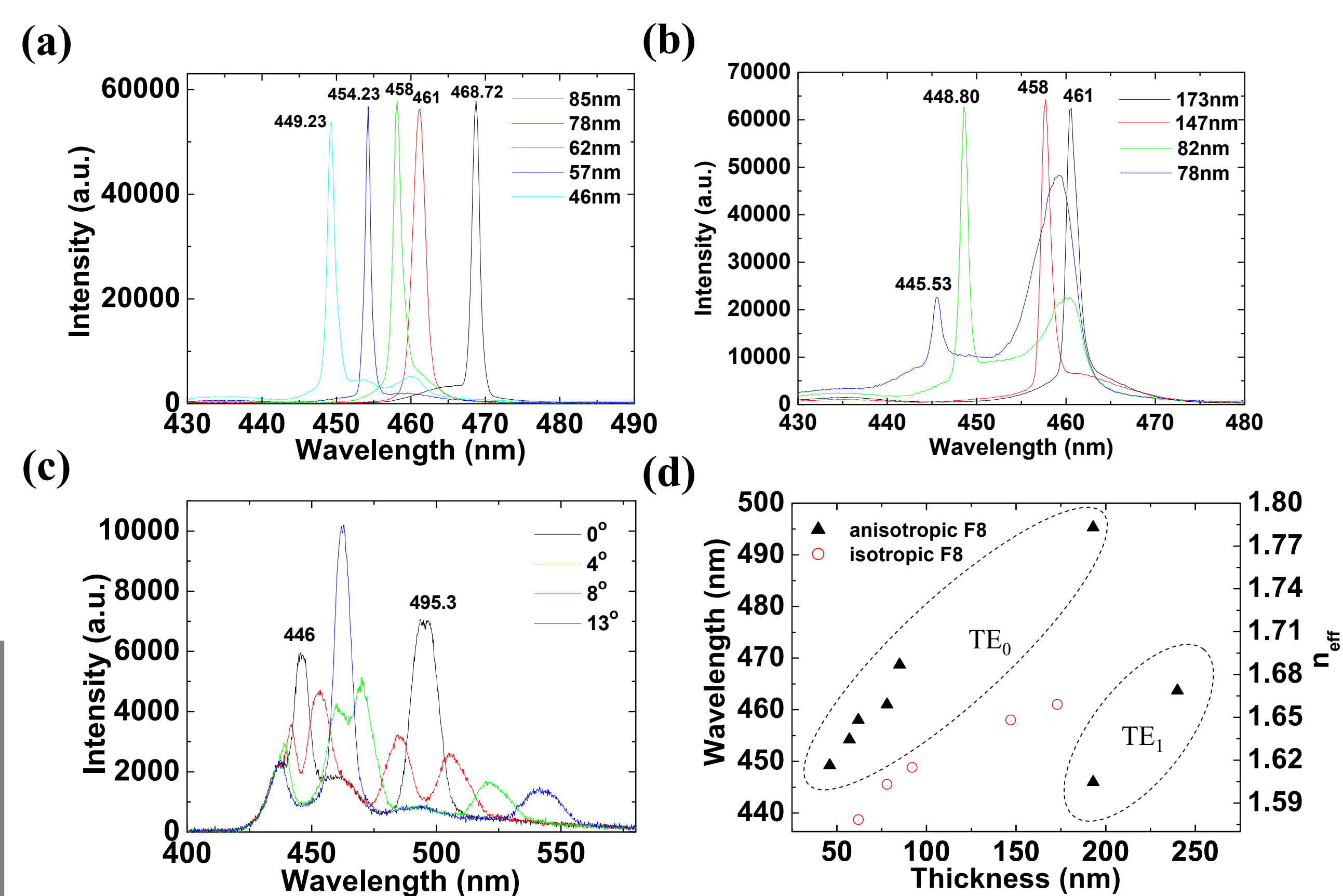
Conclusions

1. We can get the difference between aligned and unaligned F8 film due to **different n_{eff}** (different wavelength)
2. We can get **lower threshold value** by aligning F8 molecules.
 - Maximizing absorption (effective number of excitons)
 - Maximizing the amount of the emitted radiation waveguided (transition dipole moment)
3. We can **tune the wavelength of lasing** by changing the **angle** between the grating line and the orientation of the polymer molecules in the aligned F8 film. (**different refractive index (n_{eff})**).

Comparison between isotropic and anisotropic F8 layers in DFB structures



(Above) (a) Schematic of the four different excitation configurations. (b) TE-polarized emission spectra from the anisotropic F8 laser cell (the polarization beam is parallel to the F8 chain alignment) with 62nm thickness for pump energies above and below threshold. (c) Threshold behavior in the anisotropic F8 laser cell. The polarization beam parallel (perpendicular) to the F8 chain alignment corresponds to case 1 (case 2). (d) Threshold behavior in an isotropic F8 laser cell. The polarization beam parallel (perpendicular) to the F8 chain alignment corresponds to case 3 (case 4).



(Above) Lasing spectra measured (a) for the anisotropic F8 laser sample cell and (b) for the isotropic F8 laser sample cell with various film thickness of F8 layer. (c) A few photoluminescence spectra of -polarized waveguide, and inset show the effective index vs wavelength for waveguide modes in a 193nm-thick aligned F8 film. (d) Lasing wavelengths and effective refractive index of the anisotropic F8 laser sample cell (black-filled triangles) and the isotropic F8 laser sample cell (red-open circles) as a function of F8 film thickness.