Supporting Information

Carbon-bridged ($p$-phenylenevinylene) polymer for high-performance solution-processed distributed feedback lasers


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S1. Comparison of absorption and emission spectra in solution and thin-film

Figure S1: Absorption and emission spectra of poly-COPV1 in solution or thin-film. Spectra in solution were obtained using chloroform solutions with concentrations of 3 mg/L (absorption) and 0.3 mg/L (emission).
S2. Ellipsometry measurements

**Figure S2:** Refractive index ($n$) and extinction coefficient ($k$) of neat film of poly-COPV1 (thickness of 42 nm), determined by means of variable angle spectroscopic ellipsometry measurements using a J. A. Woollam Co.Inc.M2000-DI ellipsometer.
S3. Quinoidal resonance structure and molecular orbitals

Figure S3: (a) Quinoidal resonance structure of COPV1; (b) HOMO (\(\pi\)) and LUMO (\(\pi^*\)) of COPV1; (c) HOMO (\(\pi\)) and LUMO (\(\pi^*\)) of COPV6.
S4: ASE Variable Stripe Length study for determination of net gain coefficient

When ASE is the mechanism responsible for the observation of spectral gain narrowing and of a sudden increase of the output intensity at a given pump intensity (the ASE threshold), the output intensity at the end of the stripe should follow the expression:

\[ I(\lambda) = \frac{A(\lambda)I_p}{g(\lambda)} \left( e^{g(\lambda)l} - 1 \right) \]  \hspace{1cm} \text{(Eq. 1)}

where \( A(\lambda) \) is a constant related to the cross section for spontaneous emission, \( I_p \) is the pump intensity, \( g(l) \) is the net gain coefficient and \( l \) is the length of the pump stripe. Note that this expression does not take into account saturation effects appearing at thigh pump intensities.

The net gain coefficient for a given pump intensity can be determined by fitting the output intensity at the peak of the emission spectrum as a function of the pump stripe length.

![Figure S4](image.png)

**Figure S4.** Emission intensity at the wavelength at which ASE appears (\( \lambda = 527 \) nm) versus the length of the excitation stripe for a neat film of poly-COPV1 at pump intensities of 34.8 and 18.2 kW cm\(^{-2}\) (squares and starts respectively). The solid lines are fits to the data using Supplementary Equation 1, from which net gain coefficients, \( g \), of 60 cm\(^{-1}\) and 33 cm\(^{-1}\), respectively, were obtained. Note that for very long excitation lengths gain saturation is present, so only points obtained at short excitation lengths were used for the fit.
S5: Poly-COPV1 DFB lasers with substructured gratings.

Table S1. Geometrical and performance parameters of various poly-COPV1 DFB lasers with Type 2: R_{Be}a architecture. In all cases the substrate is glass, the resonator material is the mr-XNIL26 UV-NIL resist and the period of the grating unit cell is 350 nm.

<table>
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<th>Device Label</th>
<th>h (nm)</th>
<th>$\Lambda$ (nm)</th>
<th>Stamp</th>
<th>$W$ (nm)</th>
<th>$X$ (nm)</th>
<th>$\lambda_{\text{pump}}$ (nm)</th>
<th>$\lambda_{\text{DFB}}$ (nm)</th>
<th>$I_{\text{th-DFB}}$ (kW/cm²)</th>
<th>FWHM (nm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>≈140</td>
<td>350</td>
<td>A</td>
<td>95</td>
<td>75</td>
<td>445</td>
<td>534.9</td>
<td>0.7</td>
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<tr>
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<td>350</td>
<td>C</td>
<td>60</td>
<td>105</td>
<td>445</td>
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<td>1.3</td>
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<tr>
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<td>A</td>
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<td>75</td>
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<td>450</td>
<td>542.2</td>
<td>1.0</td>
<td>&lt;0.5</td>
</tr>
</tbody>
</table>

a) Number on the label refers to the device Type; b) Film thickness (error is ± 5 nm); c) Grating period; d) Width of the two ridges within the unit cell of a substructured grating; e) Separation between the two ridges within the unit cell of a substructured grating; f) Pump wavelength; g) DFB wavelength (error is ± 0.2 nm); h) DFB threshold (error ~ 10%, estimated statistically as the standard deviation from measurements on several nominally identical samples); i) DFB linewidth, defined as the full width at half of the maximum (error is ±0.5).
Figure S5. Scheme of the stamp structure used to imprint the substructured gratings indicated in Table S1.