Supplementary information:

# Graphene and chiral nematic liquid crystals: a focus on lasing

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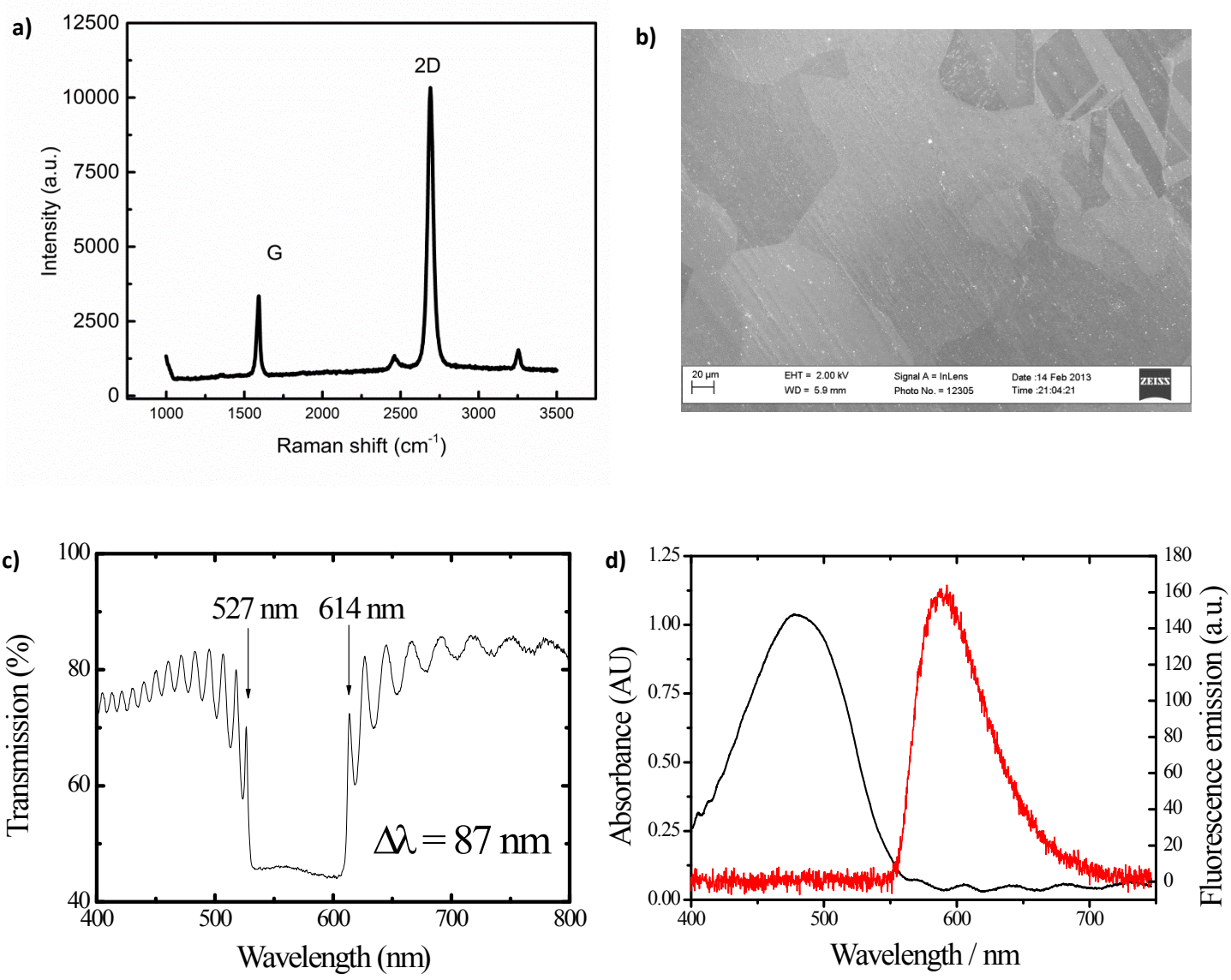



**Figure S1:** (a) Raman spectrum of CVD grown a graphene sample, and (b)SEM micrograph of polycrystalline graphene; spectra of an optimized lasing mixture (c) reflection band of chiral nematic LC and d) absorption and fluorescence spectra of the gain medium

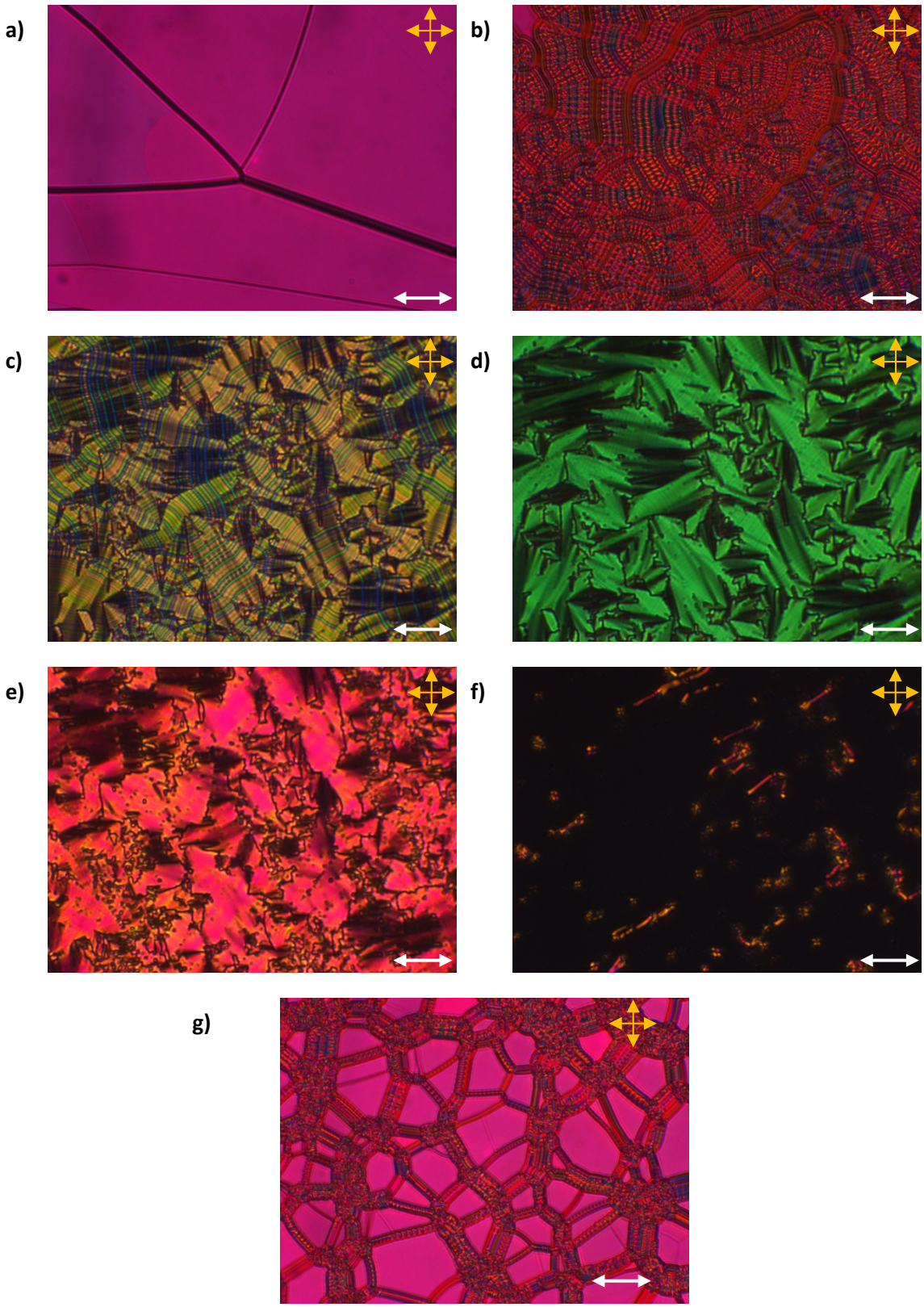
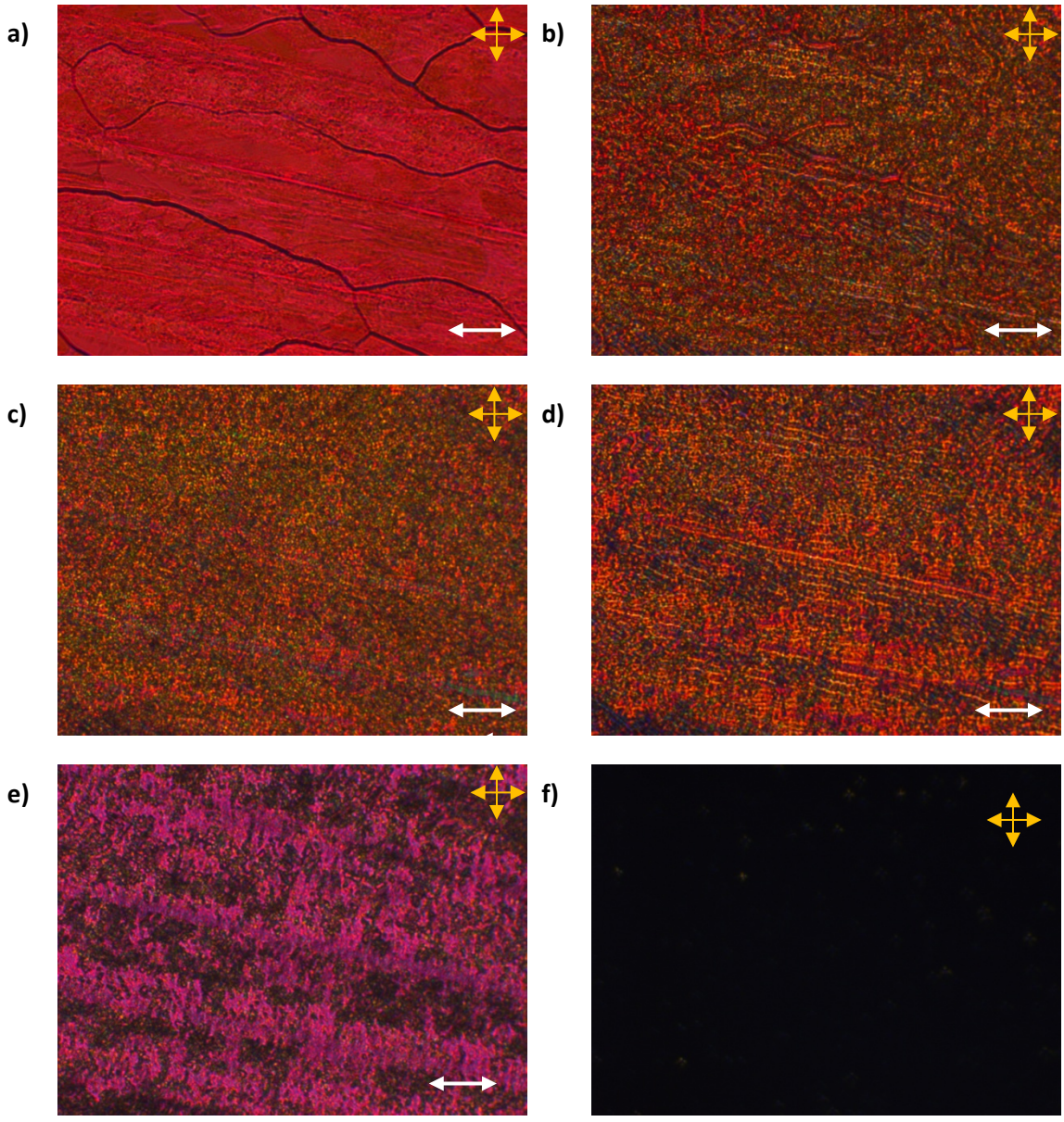



**Figure S2:** Polarizing optical micrographs of an ITO-ITO cell (planar alignment layers, filled with laser mixture) at various applied electric field, a) 0 V/μm, b) 3 V/μm, c) 5 V/μm, d) 10 V/μm, e) 15 V/μm, f) 16.5 V/μm, and g) after removing applied electric field (scale bar is 100 μm).

Figure S2 depicts polarizing optical micrographs of 10 μm ITO-ITO cell (anti-parallel alignment layers) filled with a lasing mixture under applied electric field of 0 V/μm to 16.5 V/μm. Figure 2 a) shows the cell at 0 V, the cell displayed the typical structure of chiral nematic in standing helix texture, with a few oily streaks. Upon applying 3 V/μm, the cell started to switch where finger print texture could be seen. Around 5 V/μm, the cell showed the focal conic structure which indicates that the helices are slowly moving towards random orientations. Figure 2e, increasing the applied electrical field changed the texture of the liquid crystal from lying helices to unwind nematic texture. At 16.5 V/μm, the cell reached an optically isotropic phase interspersed with the Schlieren texture of nematic liquid crystal.



g)

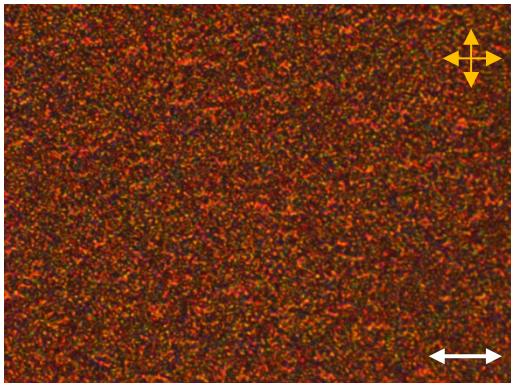


**Figure S3:** Polarizing optical micrographs of an ITO-ITO cell (homeotropic alignment layers, filled with a laser mixture) at various applied electric field, a) 0 V/μm, b) 3 V/μm, c) 4 V/μm, e) 10 V/μm f) 15 V/μm, and g) after removing applied electric field (scale bar is 100 μm).

Figure S3 shows polarizing optical micrographs of ITO-ITO cell (homeotropic alignment layer) filled with laser mixture under applied electric field of 0 V/μm to 15 V/μm. Figure S2 a) shows the cell at 0 V, the cell showed the typical structure of chiral nematic in lying helix texture, with a few see oily streaks. At 3 V/μm, the cell started to switch where finger print texture. However, at 15 V/μm, the cell reached an optically isotropic phase. This is shown in the micrograph as a dark image. Upon removing the electric field, the cell started to relax back very slowly to a random finger print texture.

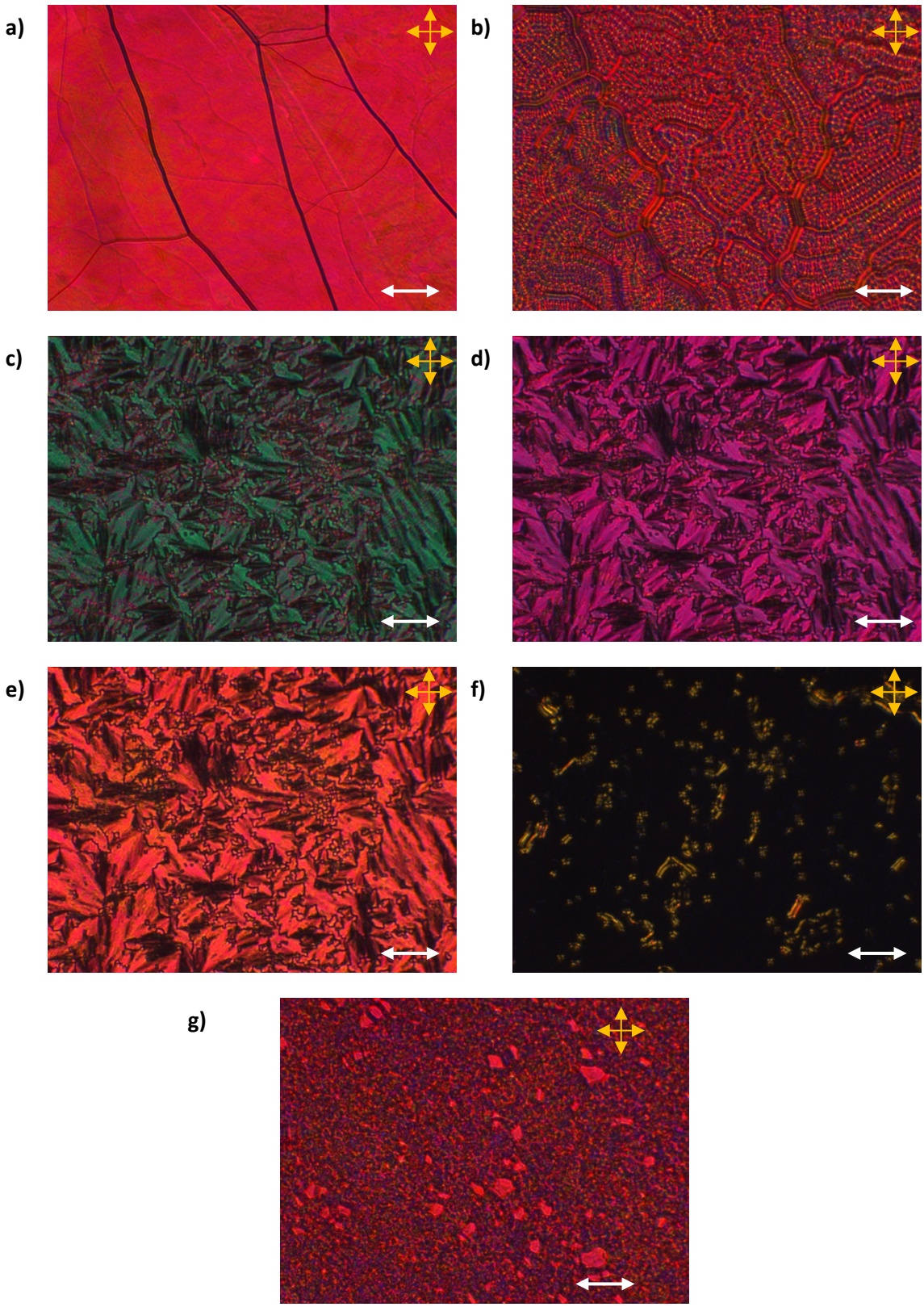



**Figure S4:** Polarizing optical micrographs of a Gr-ITO cell (filled with a laser mixture) various applied electric field, a) 0V/μm, b) 3 V/μm, c) 7 V/μm, d) 10 V/μm, e), f) 12 V/μm, g) 15 V/μm, and g) after removing applied electric field (scale bar is 100 μm).

Figure S4 Illustrates polarizing optical micrographs of 10 μm Gr-ITO cell (without alignment layer) filled with lasing mixture under applied electric field of 0V/μm to 15 V/μm. Figure 2 a) shows the cell

at 0 V/μm, a chiral nematic texture (oily streaks) and multi-domains could be observed with a Gr-ITO cell. This implies that the cell is providing a degree of alignment to the chiral nematic over the ITO-ITO (without alignment layer). At 3 V/μm, the cell started to switch where finger print and Grandjean textures could be seen at the same time. Further increase in the electrical field changed the texture to focal conic. At the same time, liquid crystal's helices have start losing its order. At 15 V/μm, the liquid crystal started to lose most of its order as it goes to isotropic phase. However, after removing the electrical field, the cell started to relax back to its original phase although the rate is much slower than ITO-ITO cell (with alignment layers).

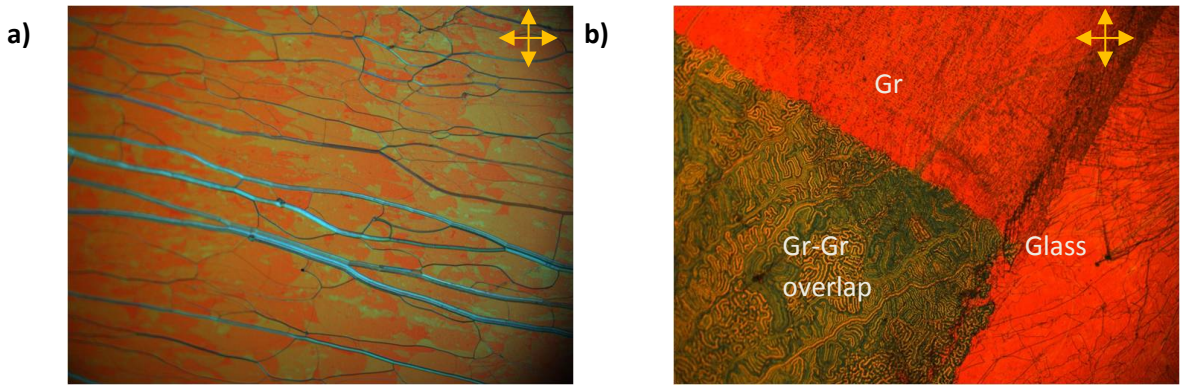



**Figure S5:** Polarizing optical micrographs of a Gr-Gr cell (filled with a lasing mixture), a) graphene region and b) Gr-Gr interface under applied electric field 3 V/μm.

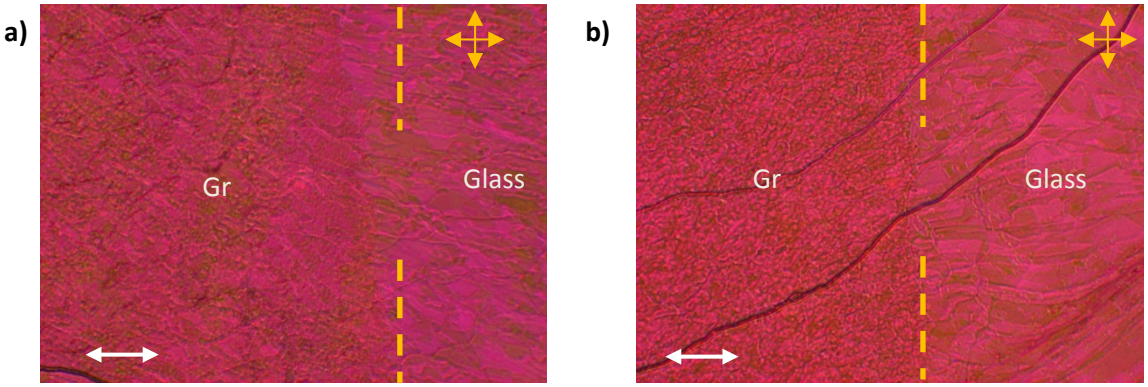



**Figure S6:** Polarizing optical micrographs of a Gr-ITO cell (filled laser mixture), a) graphene faces up, and b) ITO faces up. In both pictures, the graphene region is on the left hand side and the scale bar is 100 μm.