**Supplementary Material to**

# Ultra-short helix pitch and spiral ordering in cholesteric liquid crystal revealed by resonant soft X-ray scattering

Alevtina Smekhova,*[a] Vladimíra Novotná,[b] Ladislav Fekete,[b] Radu Abrudan,[a] Mattis Fondell,[a] Věra Hamplová[b] and Boris I. Ostrovskii*[c,d]

[a.] Helmholtz-Zentrum Berlin für Materialien und Energie, Berlin 12489, Germany.
E-mail: alevtina.smekhova@helmholtz-berlin.de
[b.] Institute of Physics of the Czech Academy of Sciences, Prague 8, Czech Republic.
[c.] Federal Scientific Research Center "Crystallography and photonics", Russian Academy of Sciences, 119333 Moscow, Russia. E-mail: ostrenator@gmail.com
[d.] Institute of Solid State Physics, Russian Academy of Sciences, 142432 Chernogolovka, Russia.

## S.1 X-ray absorption spectra

X-ray absorption spectra of EZL10/10 LC and several references collected at the Carbon K-edge resonance are shown in Fig. S1. The geometry of the experiment and the main experimental conditions were described in the main manuscript.

To distinguish the major contributions in the spectra represented by the LC sample itself and the $Si_3N_4$ membranes used in the cell at least qualitatively, the 'free path' signal without having a strongly absorbing element in the direct beam and several references were measured.

In Fig.S1 (a) the I(E) raw data of the 'free path', where I(E) represents the intensity recorded by the photodetector in the direction of the primary X-ray beam, are shown together with the intensities of incoming X-ray photons I0(E) for each linear polarization (horizontal and vertical). I0(E) signals were scaled to have the same intensity as I(E) for the 'free path' around 282.65 eV for a better comparison. Well-pronounced minima in both I0(E) spectra are related to energy dependence of X-ray reflection (and absorption) at beamline optical elements and are different for horizontal (282.75 eV and 290.65 eV) and vertical (283.98 eV and 289.56 eV) X-ray polarizations. Meanwhile, a clear difference between I(E) and I0(E) spectra recorded with horizontally polarized X-rays could be mainly assigned to the absorption of residuals in the experimental chamber and at the surface of the detector. For further analysis the function $-\ln(I(E)/I0(E))$ was chosen (Fig.S1 (b, c and d)), which accounts to the Lambert-Beer law $I(E) = I0(E) \cdot \exp(-\mu(E)\cdot t)$, where $\mu(E)\cdot t$ is a total absorption over the whole X-rays optical path, and allows to highlight the differences related solely to the absorption by the LC. For a better consistency, I(E) and I0(E) values were used in µA and nA units, respectively.

The comparison between absorption of the 'free path' and a reference $Si_3N_4$ membrane is shown in Fig.S1 (b). Due to a pronounced absorption of X-ray photons by the membrane and a linear dependence of $Si_3N_4$ transmission coefficient on energy within the C K-edge resonance (Fig.S1 (b), right scale) [29], the reference spectrum exhibits two minima described above for the incoming X-ray polarizations. A region between them does not have any sharp features, however, the absorption is visibly larger and differs from the spectra recorded without having any strongly absorbing element in the direct beam. The spectra collected from the double and single $Si_3N_4$ membranes were found to be very similar to each other (Fig. S1 (b and c)).

Contrary to this, the spectra recorded from EZL10/10 LC show a presence of a well-pronounced sharp feature at approx. 285.8 eV for all considered temperatures and both types of X-ray linear polarizations (see Fig. S1 (c and d)). Similarity of the background in the spectra recorded at 335K, 310K and RT_2 either for horizontally or vertically polarized X-rays confirms that these spectra were measured from the same spot of LC placed in between of $Si_3N_4$ membranes providing the same level of absorption. It could be considered as an additional proof that the scattering signal described in the section above was collected from the same spot on the sample for the temperatures within the second heating/cooling cycle. The spectrum recorded at RT_1 possess a bit different background around 282.75 eV which is more similar to the reference (Fig. S1 (c)): it demonstrates that this point represents a thinner LC layer which has, accordingly, a larger transmission; nevertheless, the characteristic feature at 285.8 eV assigned to the LC is still pronouncedly presented and is proportionally smaller as compared to other temperatures. The features in the absorption spectra associated mainly with the absorption by $Si_3N_4$ membranes are observed at different energies for horizontally and vertically polarized X-rays highlighting the polarization-specific energy dependence of X-ray reflection from beamline optical elements as expected; the feature associated solely with the resonant absorption in LC is found to be at the same energy.

As also follows from the Fig. S1 (c and d), no sample degradation due to radiation or heat damage as well as no a visible sample diffusion were found over the second heating/cooling cycle. Thus, a huge drop of the resonant

scattering signal described in the main manuscript could not be explained by the sample damage due to its decomposition.

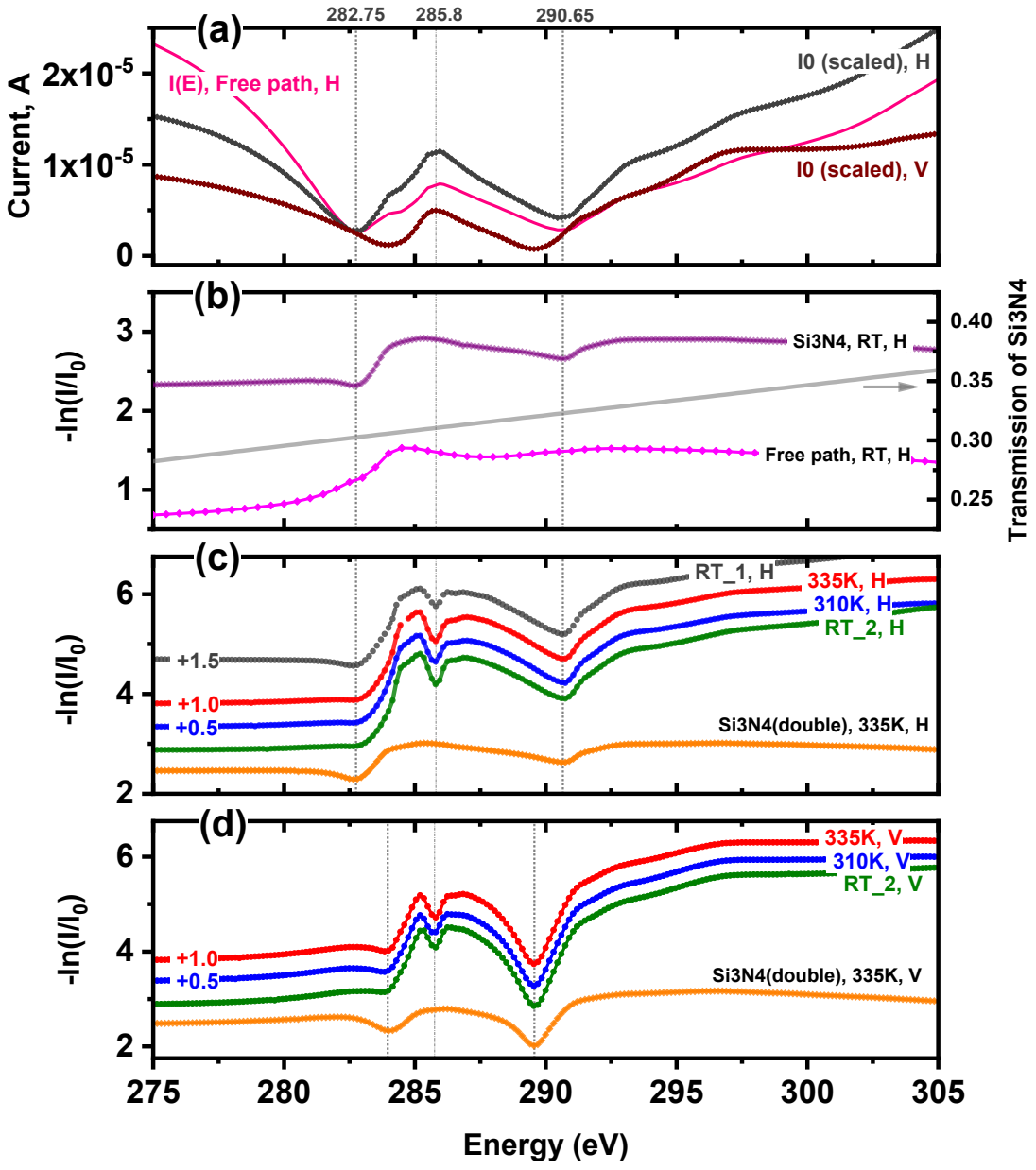


**Fig. S1. (a)** The raw data of I(E) for the 'free path' and the scaled I0(E) intensities of incoming X-ray photons both linear polarizations recorded at the Carbon K edge resonance (1s - 2p transitions). **(b)** The function -ln(I(E)/I0(E)) for the 'free path' and the $Si_3N_4$ reference (150nm) recorded in transmission with horizontally polarized X-rays. **(c)** and **(d)** The function -ln(I(E)/I0(E)) for the EZL10/10 LC sample and $Si_3N_4$ (double) reference (200 nm) recorded at different temperatures with horizontally and vertically polarized X-rays, correspondingly. Some spectra are shifted vertically for a better visibility as indicated.