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Supporting Information

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Radial Alignment of Carbon Nanotubes via Dead-End Filtration

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Derivation of the intensity measured in a Cross Polarized Microscope

Malu's law[1] describes how the transmitted light intensity I_2 drops in comparison to the incident intensity I_1 based on the angle φ between the incident polarized light and a sample acting as a linear polarizer (1). In a cross polarized microscope, an analyzer polarizer being rotated by $\frac{\pi}{2}$ compared to the polarization angle of the incident light is placed behind the sample resulting in equation (2). By inserting (1) in (2), one arrives at (3) describing the image intensity after the analyzer. Hence, the maximum intensities are found at $\varphi = \frac{\pi}{4} + n\frac{\pi}{2}$ and the minima at $\varphi = 0 + n\frac{\pi}{2}$ for $n \in N$.

$$I_1 = I_0 cos^2(\varphi) \quad (1)$$
$$I_2 = I_1 cos^2\left(\frac{\pi}{2} - \varphi\right) \quad (2)$$
$$I_2 = I_0 cos^2(\varphi) sin^2(\varphi) \quad (3)$$

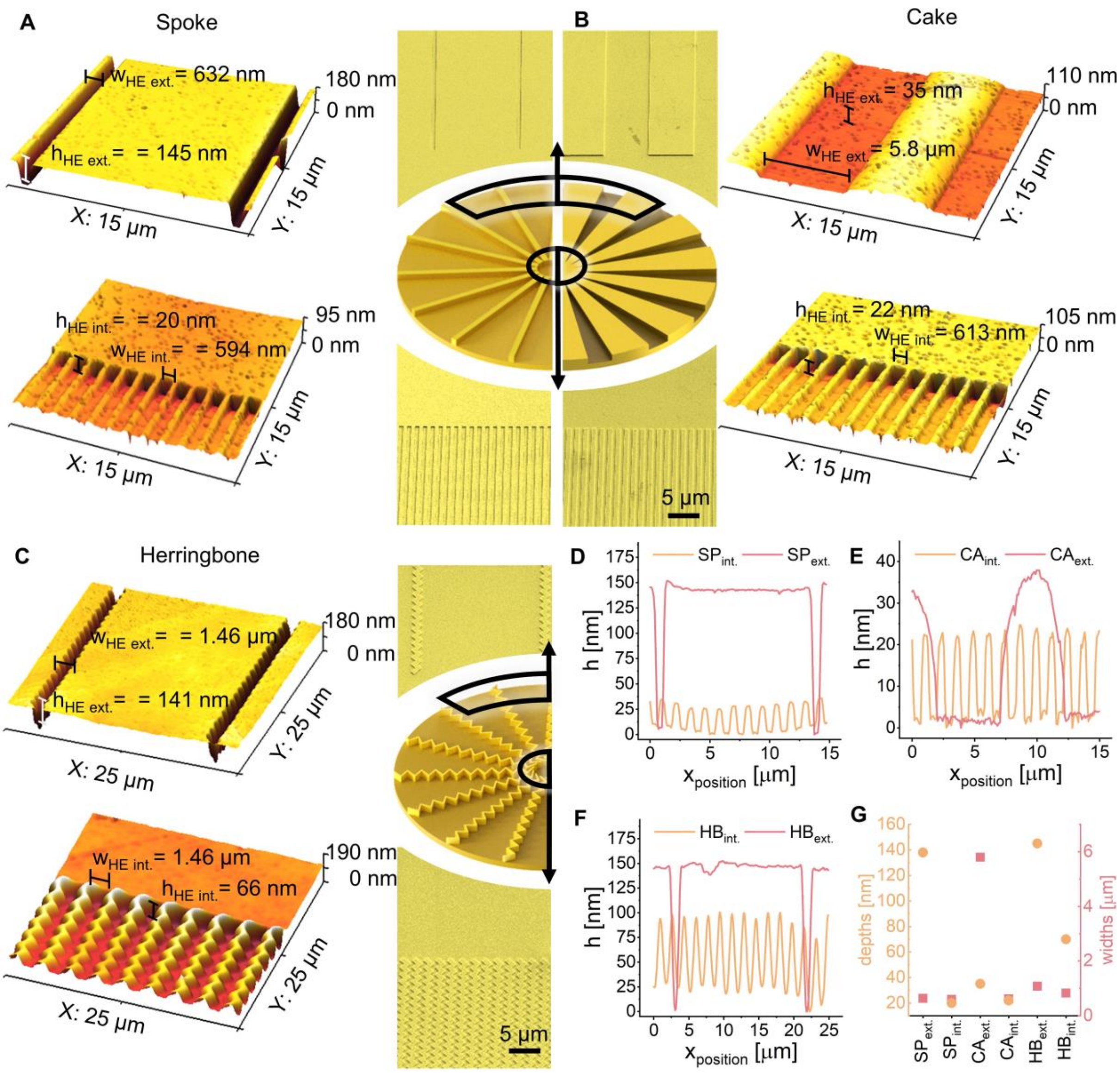

Figure S1. Schematics of the shim structures used for hot-embossing. After embossing AFM and SEM were used to characterize the structure of the (a) spoke, (b) cake and (c) herringbone patterns in the PCTE membrane. The average width, w, and structure depth, h, depicted in the topographies, were determined from the line scans shown in (D), (E) and (F).

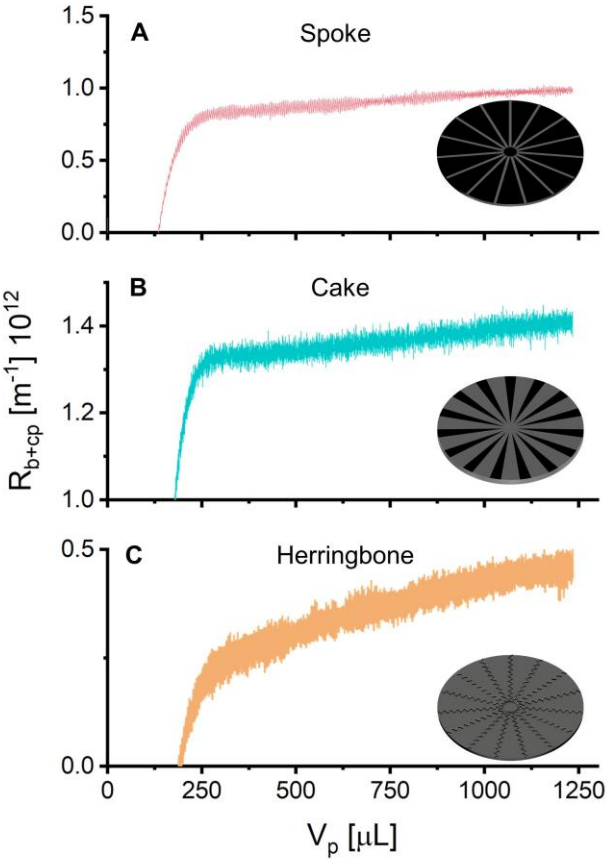

Figure S2. Evolution of the filtration resistance for 1.25 mL of 8 μg mL^{-1}EA-SWCNTs (0.04 wt% DOC) at 100 μL min^{-1} for (A) spoke, (B) cake and (C) herringbone patterned membranes. In order to calculate R_{b+cp}, the membrane resistance R_m has been determined, by passing deionized water through a membrane, prior to filtration. The final 0.75 mL were filtered at 500 μL min^{-1}and are not shown here. All filtration curves show direct cake-filtration behavior without any concentration polarization regime indicated by an immediate linear increase in resistance, except the filtration using the HB-patterned membrane, showing an intermediate blocking behavior (logarithmic increase of resistance).[2]

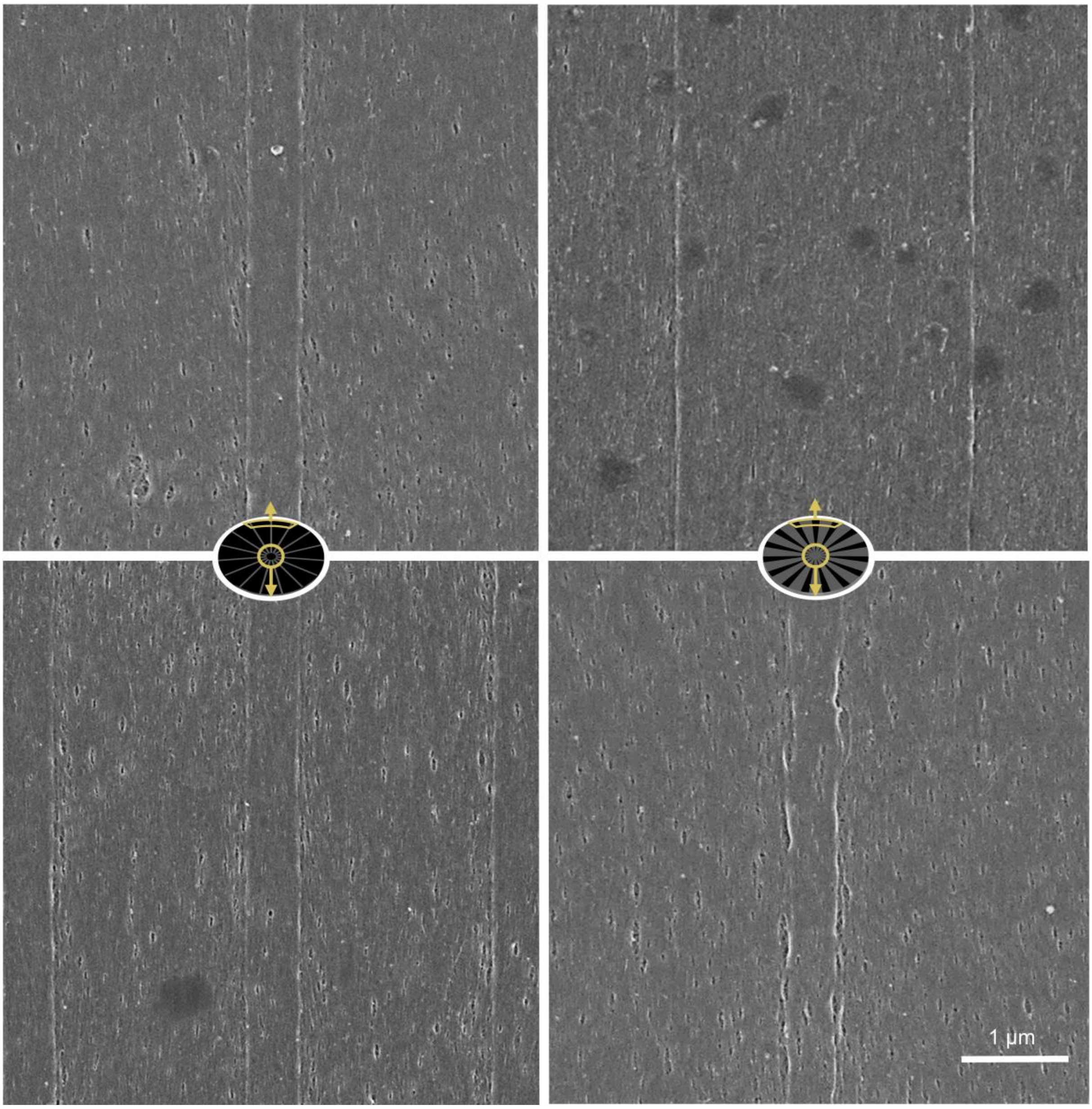

Figure S3. High magnified SEM images of the SP and CA pattern, showing the homogenous filling of the patterns..

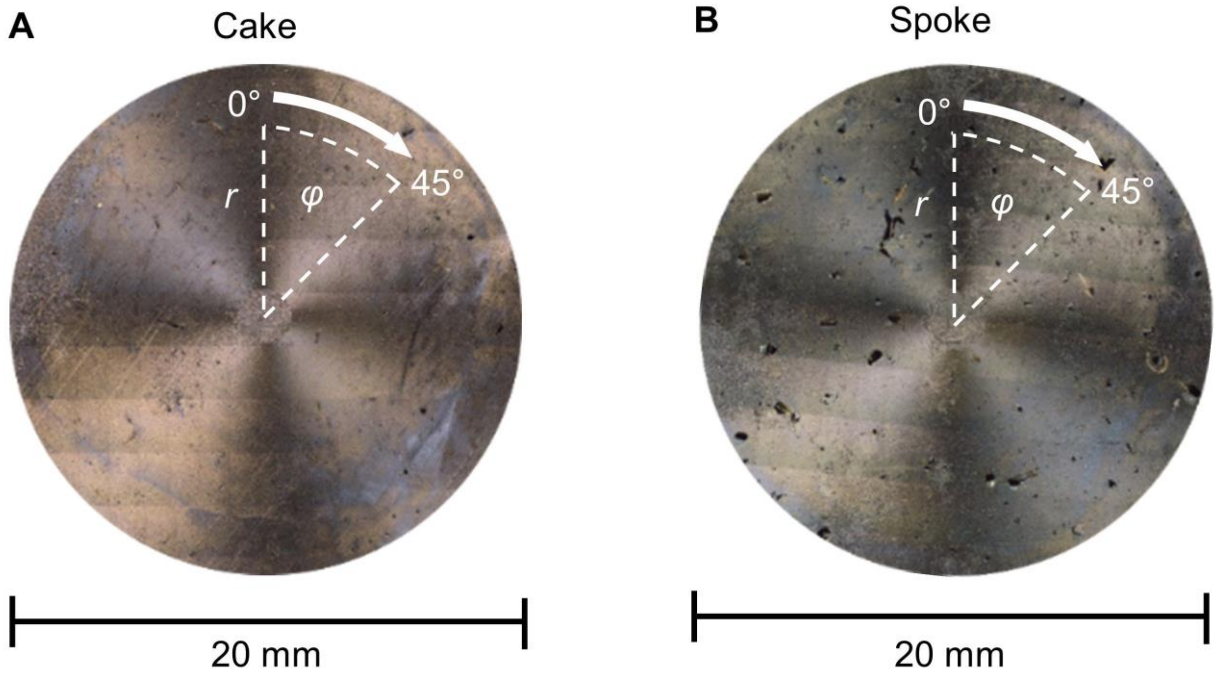

Figure S4. Placement of the radius r and film angle ϕ on the CA (A) and SP (B) films for the calculation of the accumulated intensity shown in Figure 3 (B). Therefore, the radius r is extending by 7.5 mm and does not include the unpatterned region ($r < 1$ mm) in the middle. The film angle ϕ is increasing in the clockwise direction starting from the 12'oclok position.

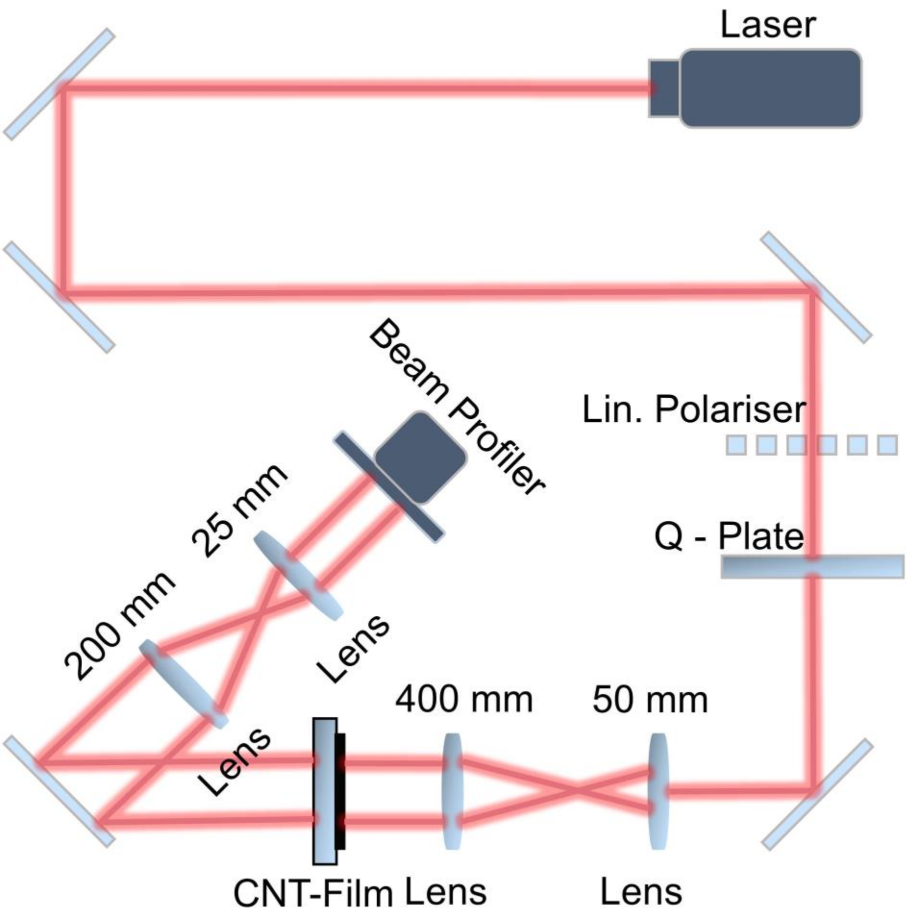

Figure S5. Optical setup used to image the beam profiles shown in Figure 4 and Figure S5. A supercontinuum laser was used to produce a 650 nm beam. This beam was either polarised linearly using a linear polarizer or polarised azimuthally or radially using the Q-plate. The beam was then passed through two acromatic lenses (focal length indicated above the lenses) to expand the beam to cover the entire film. Once transmitted, the beam is shrunk in order to fit the beam profiler.

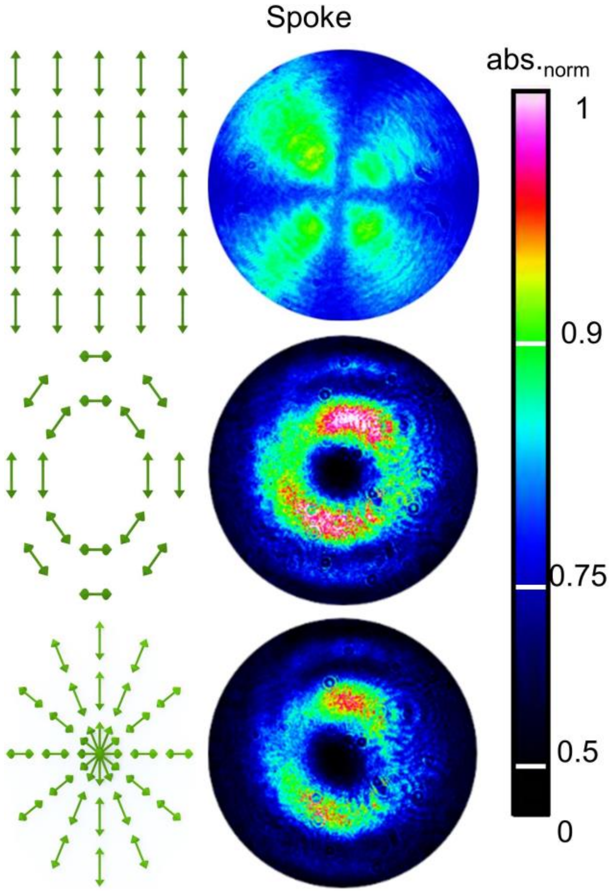

Figure S6. Laser transmittance measurements made with linear, azimuthal and radial polarized light fields with the SP film. The total power of the light reaching the beam profiler using the azimuthal light field was 5.55 μW and for the radial field 4.48 μW. .

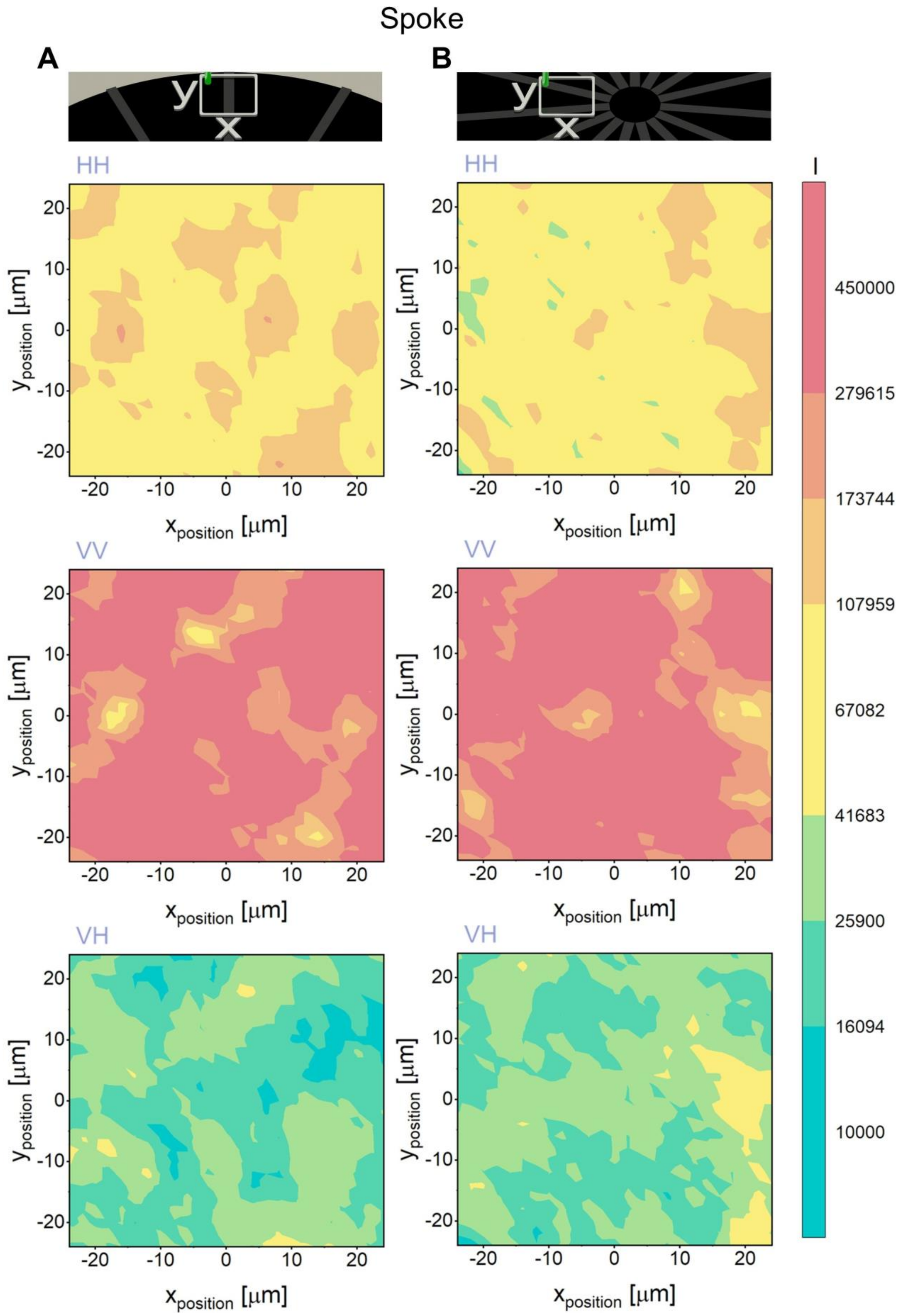

Figure S7. Intensity components I_{HH}, I_{VV} and I_{VH} used to evaluate the order parameter S_{2D} at (A) the perimeter and (B) the centre of a spoke patterned SWCNT.

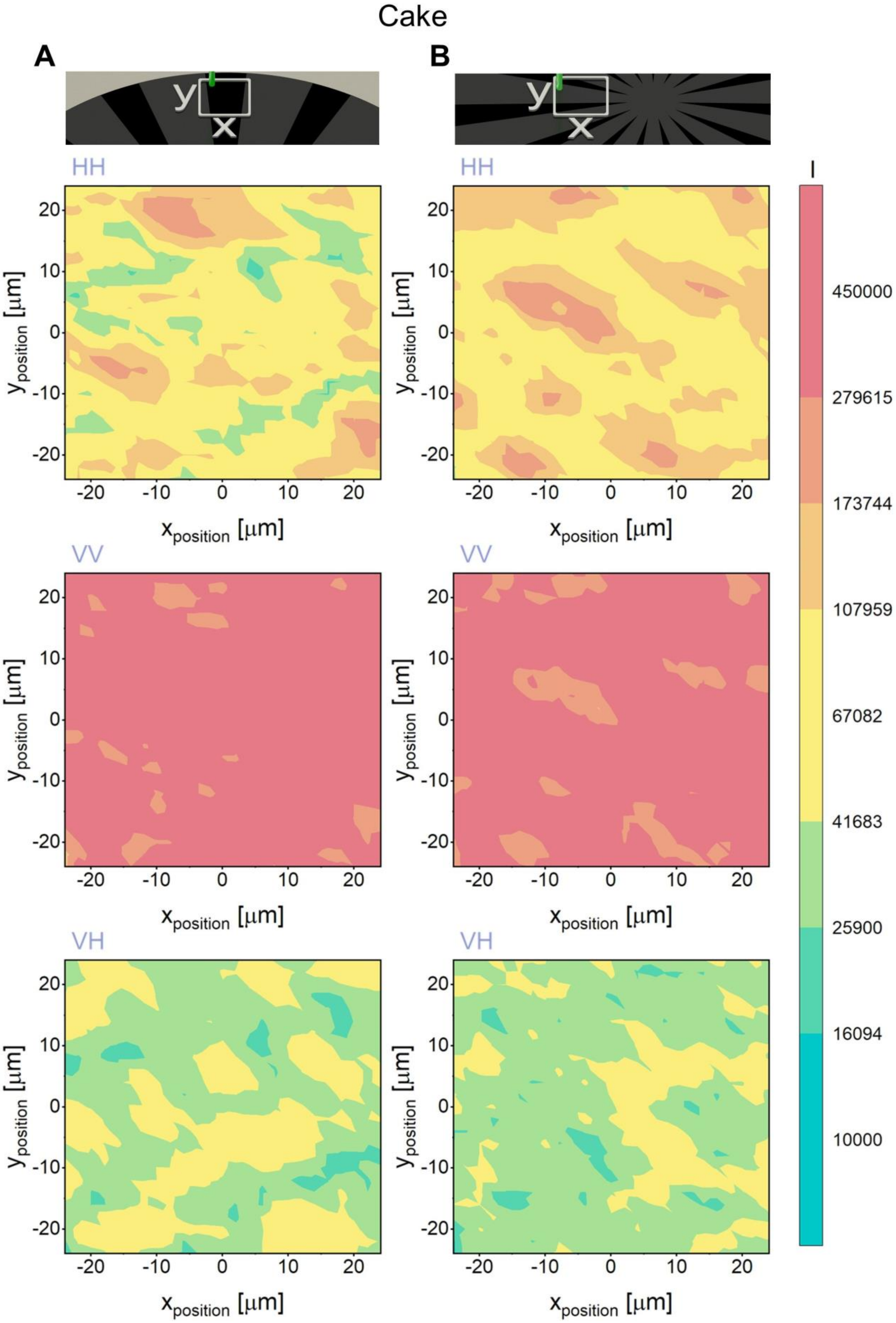

Figure S8. Intensity components I_{HH}, I_{VV} and I_{VH} used to evaluate the order parameter S_{2D} at (A) the perimeter and (B) the centre of a cake patterned SWCNT.

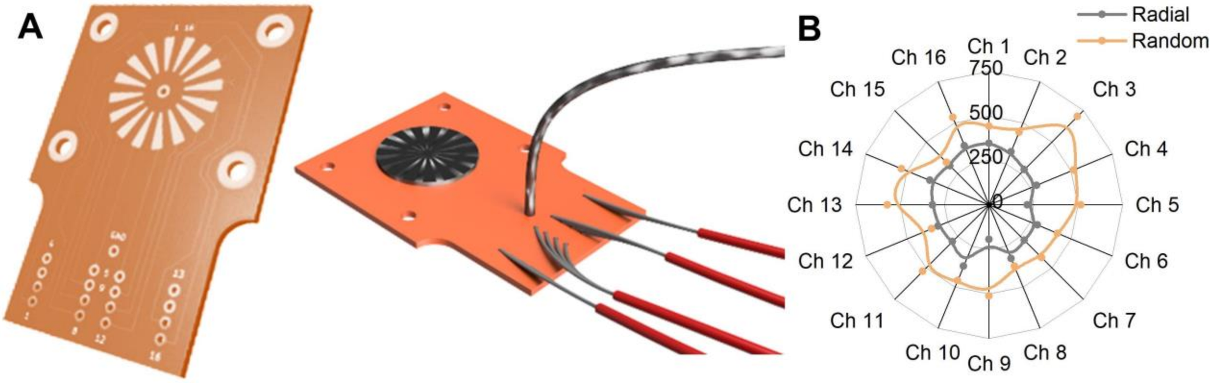

Figure S9. (A) Schematic representation of the fPCB used to measure the resistance of the SWCNTs. The distance between the ground pin located in the middle and the outer contact was 2.7 mm. (B) Resistances measured at each channel for a radially aligned and random SWCNT film.

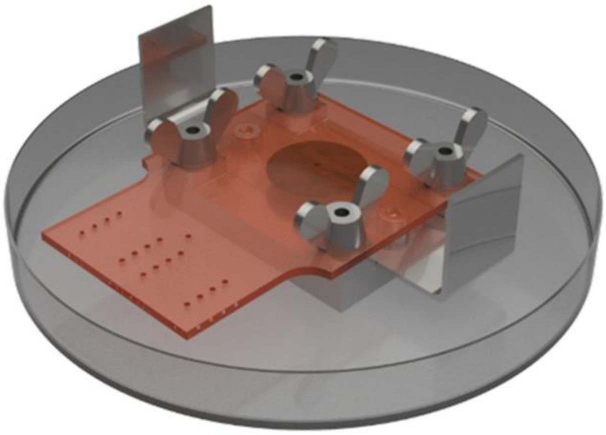

Figure S10. Custom built transfer station made to hold the polyimide taut whilst the membrane is dissolved facing downwards. We found the films to be less likely to rupture when the chloroform is filled in carefully until it interfaces the membrane instead of using a syringe.[2a, 3] In order to prevent the Chloroform from evaporating during the transfer (30 min) a larger Petri dish is used to cover the top of the holder.

References

[1] W. P. S. Freitas, C. R. Cena, D. C. B. Alves, A. M. B. Goncalves, *Physics Education* **2018**, 53, 035034.

[2] a) C. Rust, H. Li, G. Gordeev, M. Spari, M. Guttmann, Q. Jin, S. Reich, B. S. Flavel, *Advanced Functional Materials* **2022**, 32, 2107411; b) E. Iritani, *Drying Technology* **2013**, 31, 146.

[3] J. S. Walker, J. A. Fagan, A. J. Biacchi, V. A. Kuehl, T. A. Searles, A. R. Hight Walker, W. D. Rice, *Nano Lett.* **2019**, 19, 7256.