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Learning Analysis of Liquid Crystal Crystallization Using Polarized Light Microscopy and U-Net Segmentation

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Understanding crystallization processes is fundamental for controlling the physical properties of advanced materials. In this work, we investigate the crystallization behavior of the liquid crystalline compound 4-nonyloxybenzylidene-4′-propylaniline (9BA4) during cooling at multiple rates using polarized light microscopy to track the evolution of characteristic textures. The kinetics of crystallization was quantified as a function of temperature, and the temperature corresponding to the maximum crystallization rate was determined by fitting a sigmoidal function to the experimental data [1]. The resulting crystallization data were subsequently analyzed within the Ozawa model [2]. To enable objective and automated phase identification, a U-Net based deep learning model [3] was employed to perform semantic segmentation of microscopy images. This approach allows reliable discrimination between crystalline (Cr) and smectic C (SmC) phases and enables the generation of probability maps used for quantitative analysis. The presented approach demonstrates that neural network assisted image analysis significantly enhances the extraction of quantitative kinetic information from complex texture evolution during phase transitions.

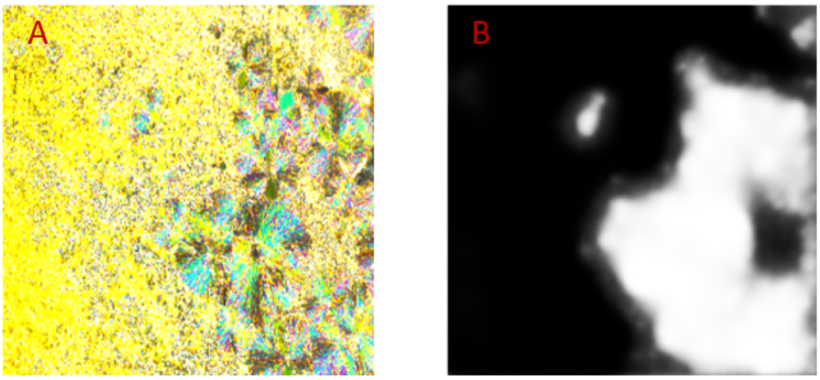

Figure 1. Comparison of original image observed at a temperature of 358.5 K under a cooling rate of 20 K/min (A) and predicted by the U-Net network mask (B).

References

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