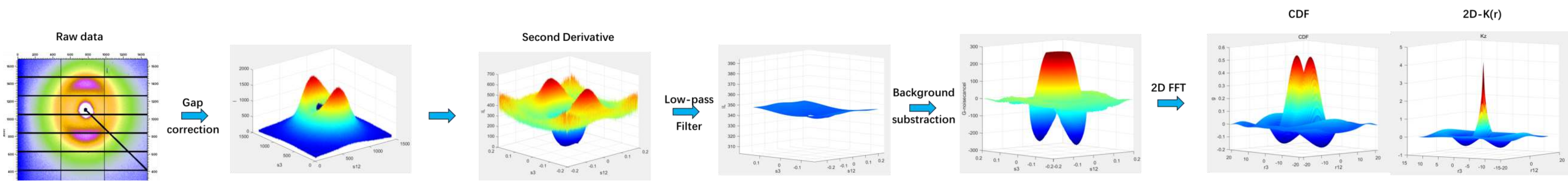
Characterizing microstructural differences in anisotropic polymeric films Using Two-Dimensional Chord Distribution Functions and Correlation Function

Yuchuan Tian, Junyu Li*, Yuhong Zhang and Junyan Liu*
Sinopec Shanghai Research Institute of Petrochemical Technology, Shanghai, PR China
*Liujy.sshy@sinopec.com *Lijy.sshy@sinopec.com

Introduction

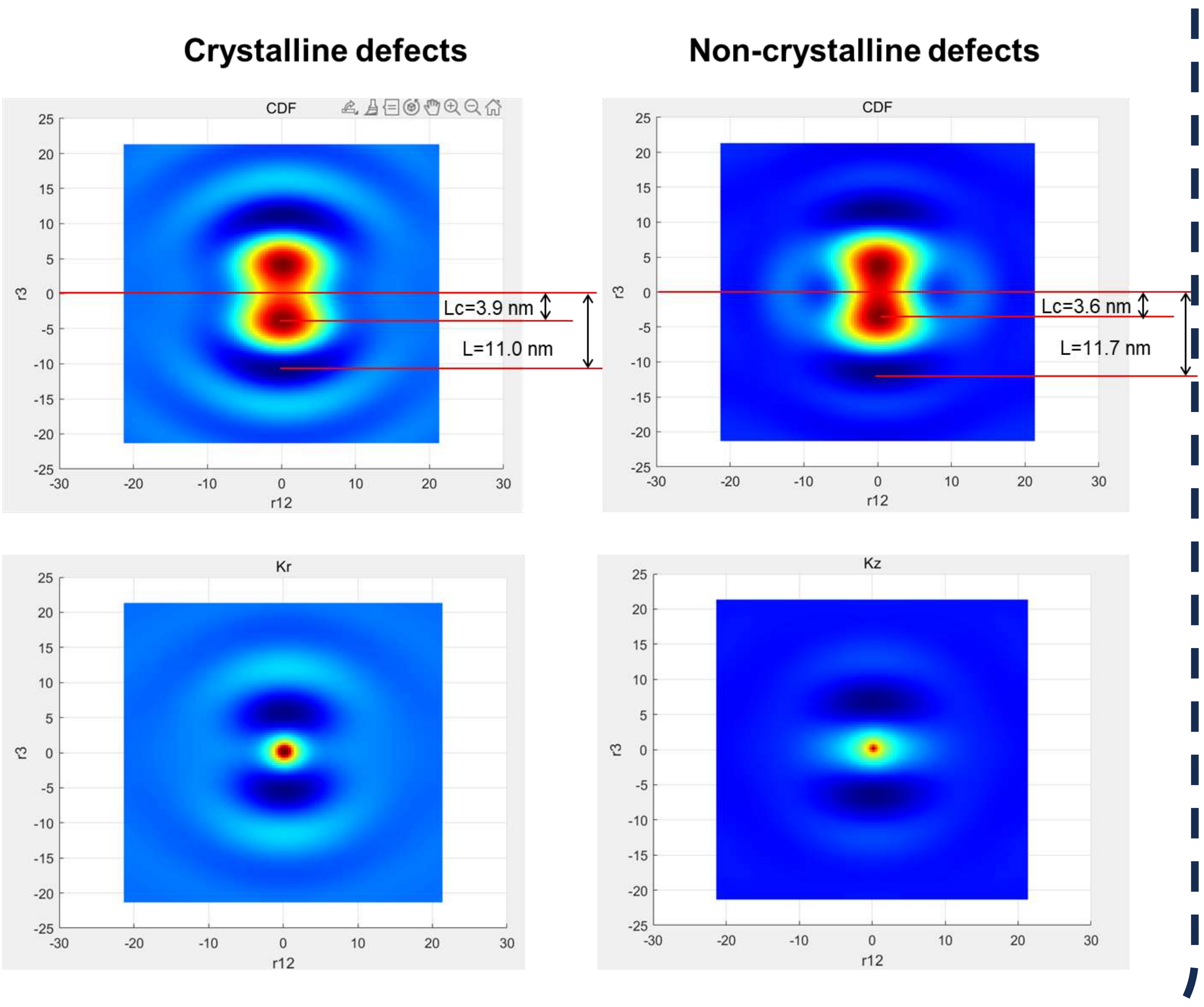
Crystalline defects diminish the performance of polymer films, highlighting the need for precise structural characterization. This study, for the first time, applies two-dimensional chord distribution functions (CDF) and correlation functions K(r), derived from small-angle X-ray scattering (SAXS), to investigate lamellar structures in uniaxially stretched poly(glycolic acid) (PGA) cast films. CDF and K(r) were calculated from 2D Fourier transforms of the scattering intensity $I(s_{12}, s_3)$, weighted by $4\pi^2 s^2$. Background signal was subtracted using low-pass filter, and image refinement was achieved with MATLAB, involving gap correction, noise suppression, and enhancement of two-dimensional CDF images.

Methods

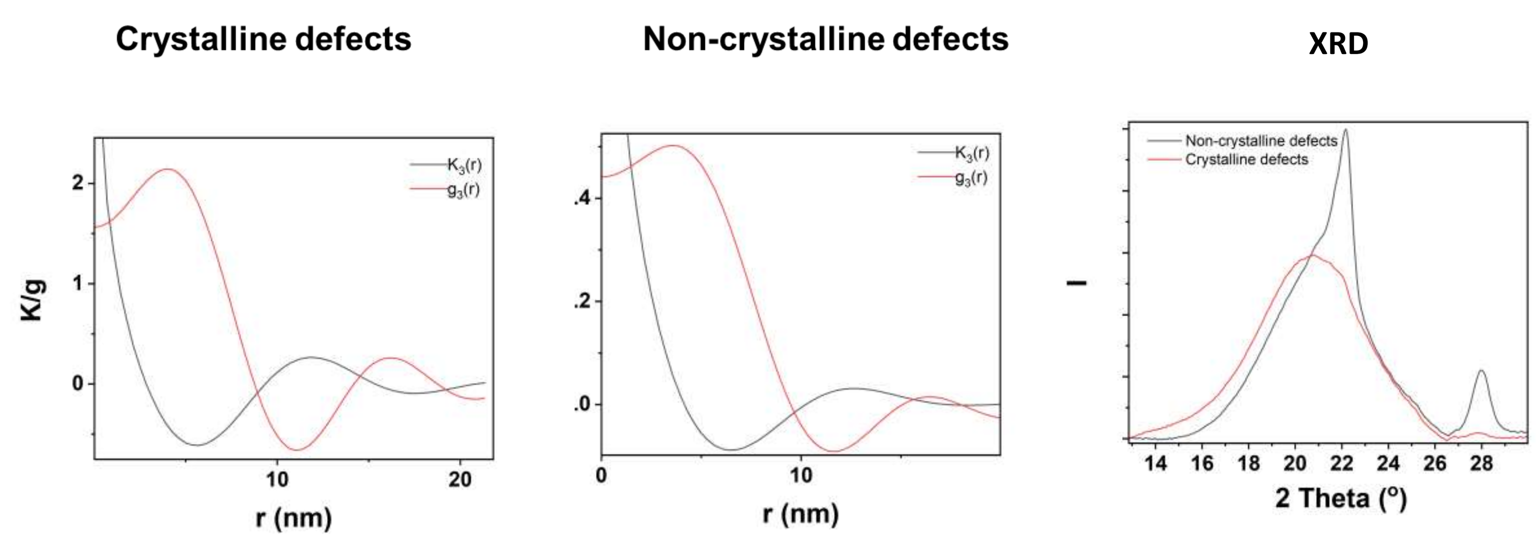


Results

CDF and 2D-K(r)



Lamellar Structure



Calculating results

		Lc (nm)	L (nm)	Lc/L (%)
CDF	Crystalline defects	3.9	11.0	35
	Non-crystalline defects	3.6	11.7	31
2D-Kz	Crystalline defects	3.9	11.7	33
	Non-crystalline defects	3.8	12.8	30

Conclusions

- Two-dimensional CDF and correlation function reveal higher lamellar density, thickness, and tighter packing at Crystalline defects compared to non-defect regions.
- WAXS results indicated enhanced crystallinity at defects.
- These study provide crucial insights for controlling anisotropic microstructures during film casting.

Acknowledgements

- X-ray measurement was provided by the Shanghai Synchrotron Radiation Facility (SSRF).
- This work was supported by Sinopec Shanghai Research Institute of Petrochemical Technology.