# Formation of Nano Oriented Crystals of iPP with Soluble Nucleating Agent by Elongational Crystallization

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## Introduction

We found that iPP crystallizes into "nano-oriented crystals (NOCs)" by elongational crystallization from the melt when the elongational strain rate ($\dot{\varepsilon}$) becomes larger than a critical one ($\dot{\varepsilon}^*$) [1,2]. Purposes of this study are to show that the elongational crystallization of iPP with soluble nucleating agent (NA) results in formation of NOCs and that the NOCs showed high tensile properties.

## Experimental

We used iPP ($M_w$=32.6×10$^4$、$M_w/M_n$=11.4, [mmmm]=98%) and soluble NA (1,2,3-Trideoxi-4,6:5,7-bis-O-[(4-propylphenyl) methylene]-nonitol, TBPMN). The concentration of the NA was 1wt%. We used a roll system. $\dot{\varepsilon}$=73s$^{-1}$. We observed the structure by means of polarizing optical microscope (POM) and small/wide angle X-ray scatterings (SAXS/WAXS) from directions, through, edge and end. We observed the stress ($\sigma$) and strain ($\varepsilon$) and obtained the maximum tensile stress ($\sigma_{max}$) and the tensile modulus ($E_t$).

## Results and Discussion

POM images suggested the formation of NOCs. SAXS patterns showed two-point pattern and an ellipsoidal pattern (Fig.1**a,c&e**). WAXS patterns showed fiber and arc pattern along machine direction (MD) for through and edge views, while unoriented pattern for end view (Fig.1**b,d&f**). Therefore, we concluded the formation of NOCs. High $\sigma_{max}$ and $E_t$ were showed: $\sigma_{max}$=95MPa and $E_t$=4.0GPa for MD and $\sigma_{max}$=38MPa and $E_t$=2.6GPa for transverse direction (TD), respectively.

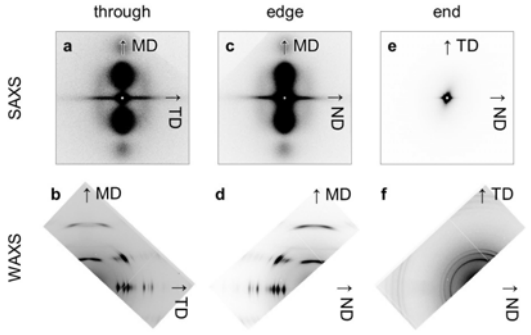


**Fig.1** X-ray images of NOCs. **a&b.** Through-view. **c&d.** Edge-view. **e&f.** End-view. **a,c&e.** SAXS images. **b,d&f.** WAXS images.

## Conclusion

Elongational crystallization of iPP with soluble NA results in formation of NOCs. The NOCs showed high tensile properties.

## References

[1] Okada, K. *et al. Polymer J.*, **42**, 464 (2010).
[2] Okada, K. *et al. Polymer J.*, **45**, 70 (2013).