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Phase Transition Behavior of Organic Thin Film Observed High Sensitive DSC

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Introduction

With decreasing the size of material, the structure and the molecular mobility of materials are influenced by the material-gas interface (surface) and the material-substrate interface (interface) due to the decrease of surface/volume ratio. The glass transition of polymer-gas surface is lower than that of bulk polymer, and the molecular mobility of polymer-solid substrate interface is expected to be lower than that in bulk polymer due to the attractive interaction between polymer and substrate surface. In this study, the phase transitions of organic thin films with thickness less than 1 μm were investigated as a function of thickness.

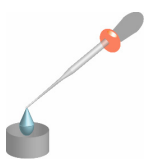
Experiment

Sample

• Poly(ethylene oxide) PEO : $CH_3(OCH_2CH_2)_mCH_3$
m = 114, 272, and 454, mono-dispersed

Preparations

• Toluene solution of PEO, 0.1 to 1.0 wt%
• Solvent casting, 5 to 10 μℓ on aluminum open pan



Experiments

• **DSC :** X-DSC7000 (SII NanoTechnology)
Temperature : 290 → 350 → 290 → 350 K
Scanning Rate : 5 K/min
• **AFM :** E-sweep (SII NanoTechnology)
Dynamic force mode
Cantilever
Spring constant : 40 N/m
Resonance frequency : 310 kHz

Results

DSC heating curves of PEO_{272}

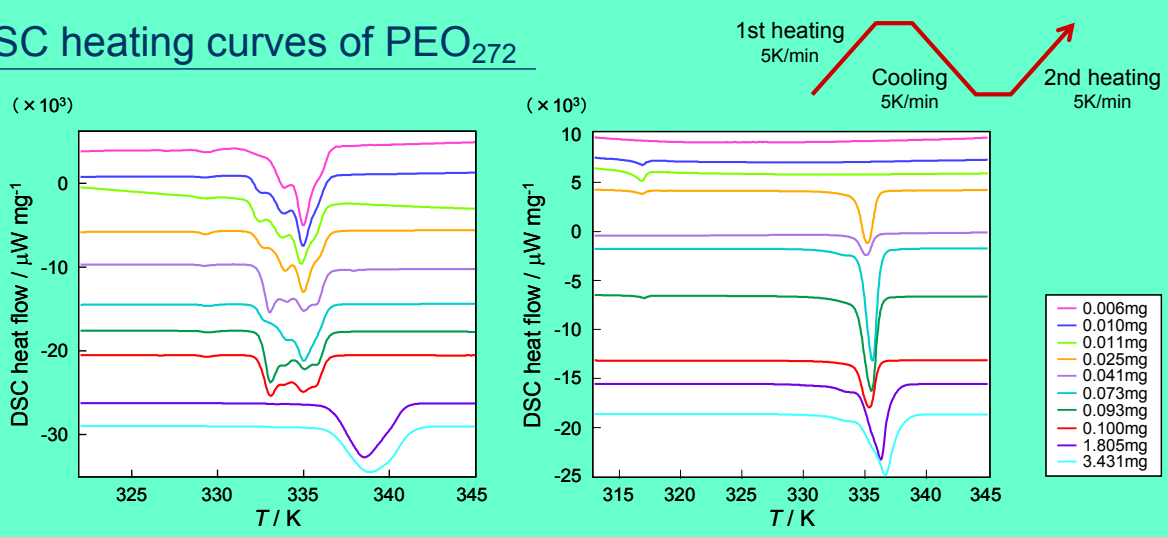


Fig.1 DSC curves of 1st heating for PEO_{272}

Fig.2 DSC curves of 2nd heating for PEO_{272}

DSC cooling curves of PEO_{272}

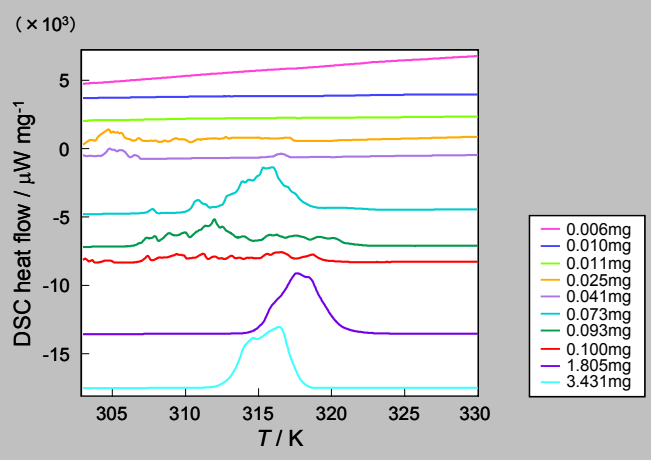


Fig.5 DSC curves of cooling for PEO_{272}

■Melting temperature of Micro phase

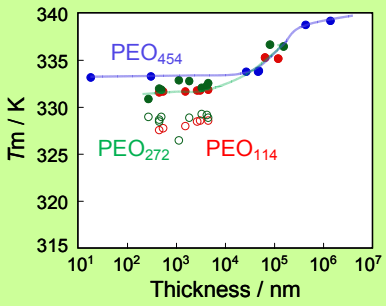


Fig.3 Relations between melting temperature and the thickness in 1st Heating

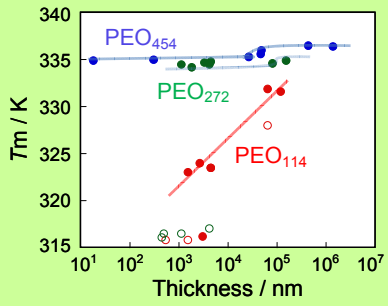


Fig.4 Relations between melting temperature and the thickness in 2nd Heating

■Crystallization process of Micro phase

Nucleation process

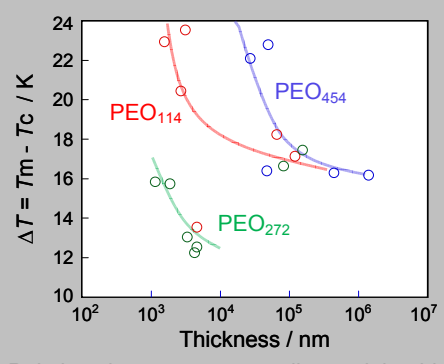


Fig.6 Relations between supercooling and the thickness

Crystal growth process

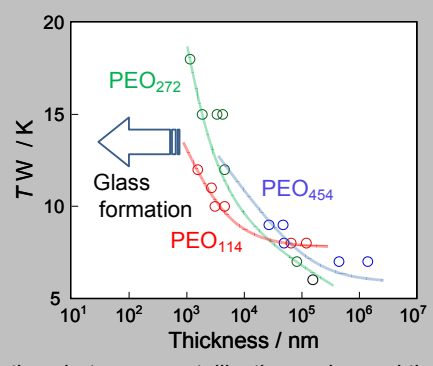
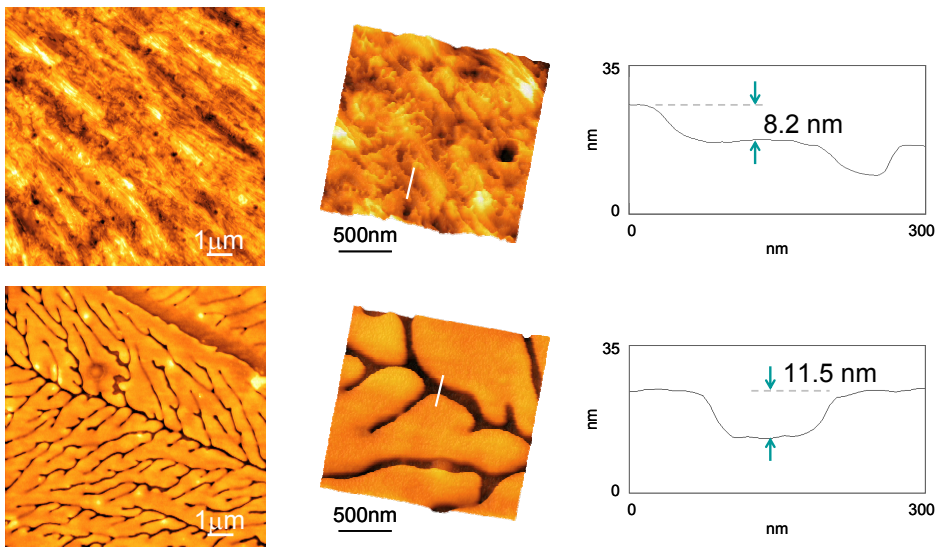


Fig.7 Relations between crystallization region and the thickness

Surface structure (AFM topography and line profile of PEO_{272})

Cast film
1st heating



Cooled film
2nd heating

Conclusion

• Melting temperature decreased with decreasing thickness. In the thin film with 1 μm thickness, two types of crystal existed.
• Crystallization process delayed by the interaction between PEO and the substrate surface.
• The effect of molecular weight on the retardation of nucleation process was observed.