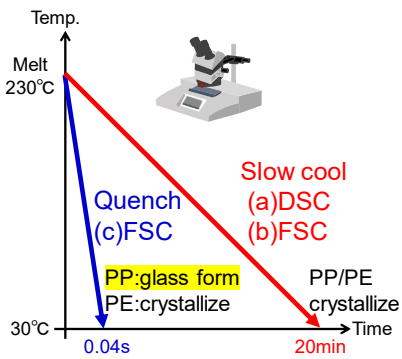
Determination of mass fraction in polypropylene / polyethylene blends using fast scanning calorimetry

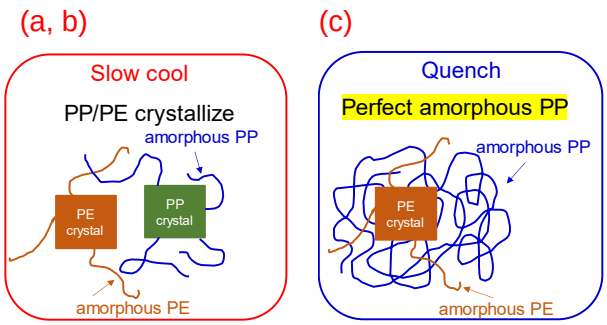
In the material recycling of polymer materials, recycled pellets are used, which are obtained from polyethylene (PE) or polypropylene (PP) recovered from markets and processes. It is necessary to determine the content of PE/PP in the samples quickly and accurately. Toray Research Center established a quantitative method for determining the PP/PE ratio based on its thermal property.

Methodology using differential scanning calorimetry (DSC) and fast scanning calorimetry (FSC)

Sample preparations



Schematic model of samples



The structure is controlled through cooling within the calorimeter.

Methodology

< Determination >

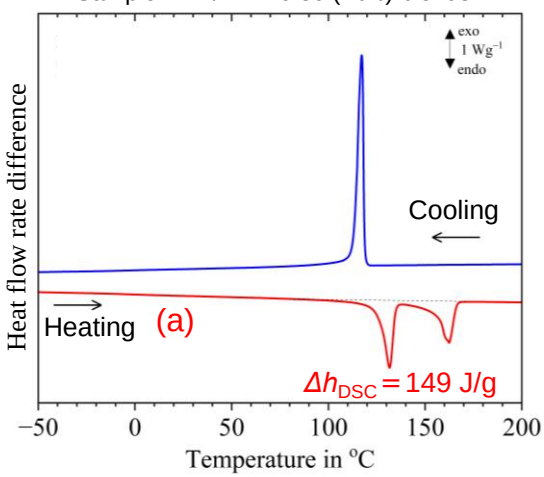
(a) DSC;
Heat of fusion: Δh_{DSC}

(b) FSC;
Heat of fusion: ΔH_{FSC}
Total mass: $M_{total} = \Delta H_{FSC} / \Delta h_{DSC}$

(c) FSC;
Heat capacity change at T_g : ΔC_p
PP mass : $M_{PP} = \Delta C_p / \Delta c_{p,ref}$
PE mass : $M_{PE} = M_{total} - M_{PP}$
($\Delta c_{p,ref}$: 0.4563 J/K/g)

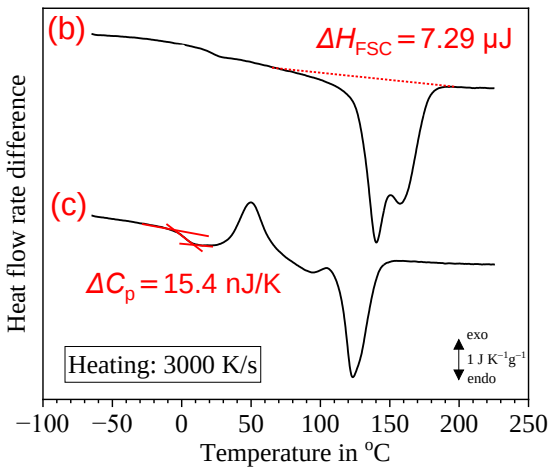
DSC curves (a)

Sample : PP/PE=70:30 (wt%) blends



FSC curves (b),(c)

Sample : PP/PE=70:30 (wt%) blends



$M_{Total} = 49$ ng

$M_{PP} = 34$ ng

$M_{PE} = 15$ ng

Weight fraction of PP/PE blends: PP/PE=69/31 in wt%

The compounding mixing ratio of PP/PE and the thermal analysis method are consistent (a standard deviation of present method was 1 wt%)

Verification with actual recycled materials

The ^{13}C NMR provides high accuracy in determining the blending ratio of PP/PE blends. However, it can be more challenging due to operations such as dissolution in high-temperature solvents, and it is less convenient compared to thermal analysis methods.

PP/PE recycled polymer	PP / PE weight fraction (wt%)	
	^{13}C NMR	Thermal method
#1	87 / 13	88 / 12
#2	82 / 18	83 / 17
#3	74 / 26	74 / 26

It is possible to determine the blending ratio of PP/PE blends with a similar accuracy as ^{13}C NMR and obtain the information on thermal properties, but with greater simplicity.

Toray Research Center, Inc.