

DMA No. 5 JUN.1989

Dynamic Viscoelastic Data of Polyethylene

- 1. Sample** Low Density Polyethylene : LDPE (Brand Name : Mirason 68)
 High Density Polyethylene : HDPE (Brand Name : Hi Zex 5000F)
- 2. Chemical Structure** $\text{---} \left(\text{CH}_2\text{---CH}_2 \right)_n \text{---}$
- 3. Thermal History** LDPE Press film : after pressing at 150 allowed to cool to room temperature.
 HDPE Press film : after pressing at 180 allowed to cool to room temperature.
- 4. Instruments** SDM5500 Rheol. Station
 DMS100 Dynamic Mechanical Spectrometer
- 5. Conditions** Deformation mode : Bending mode
 Sample Size : LDPE 20.00(ℓ) × 12.05(w) × 1.70(t)mm
 HDPE 20.00(ℓ) × 6.45(w) × 2.22(t)mm
 Temperature Range : LDPE -150 ~ 90
 HDPE -150 ~ 130
 Heating Rate : 2K/min
 Atmosphere : N₂
 Frequency : 0.5,1,2,5,10Hz

6. Transition temperature and activation energy based on tanδ

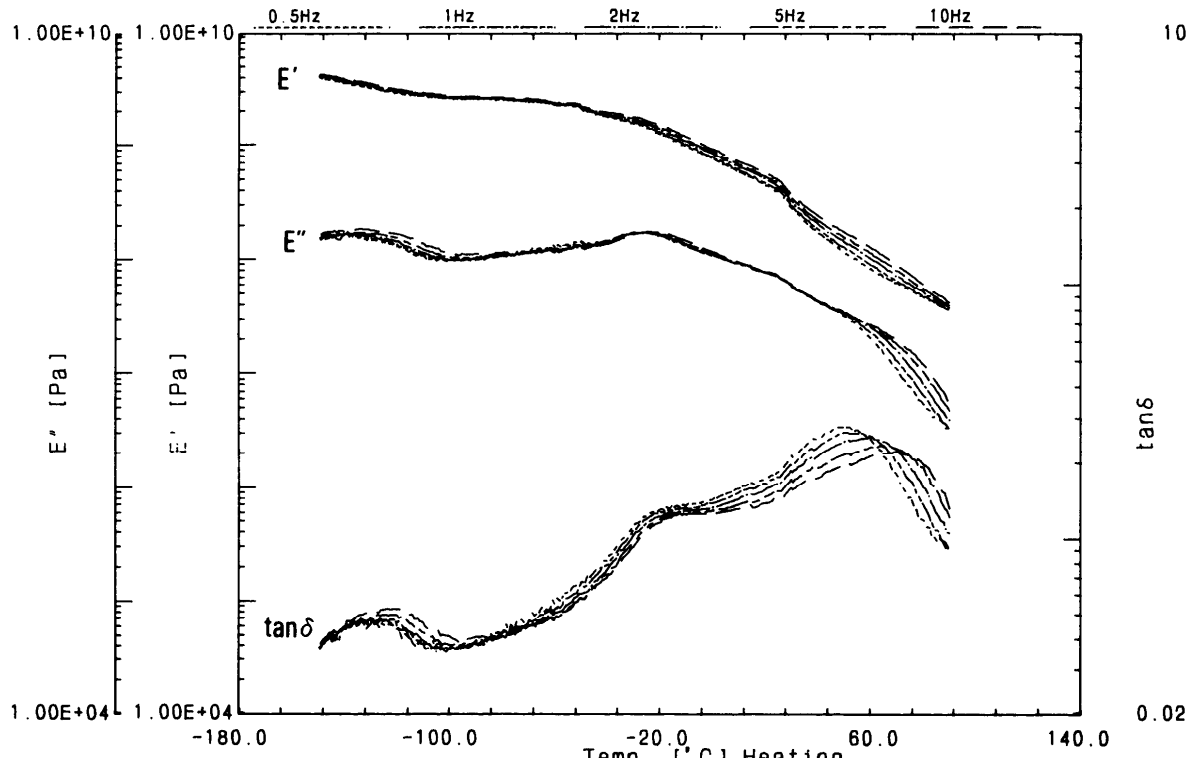
	LDPE		HDPE		Comments
	Transition Temp.()	ΔEa (kJ/mol)	Transition Temp.()	ΔEa (kJ/mol)	
α Transition	54 (1Hz)	145	119 (1Hz)	-	Crystal Relaxation
α' Transition	-	-	79 (1Hz)	-	Grain Boundary relaxation
β Transition	-19 (1Hz)	-	-32 (1Hz)	-	Glass Transition
γ Transition	-124 (1Hz)	69	-121 (1Hz)	129	Local mode relaxation

7. Thermal Analysis Data

LDPE T_m : 106.2 , ΔH_m : 139.6 J/g, DSC 10K/min
 HDPE T_m : 132.1 , ΔH_m : 219.4 J/g, DSC 10K/min

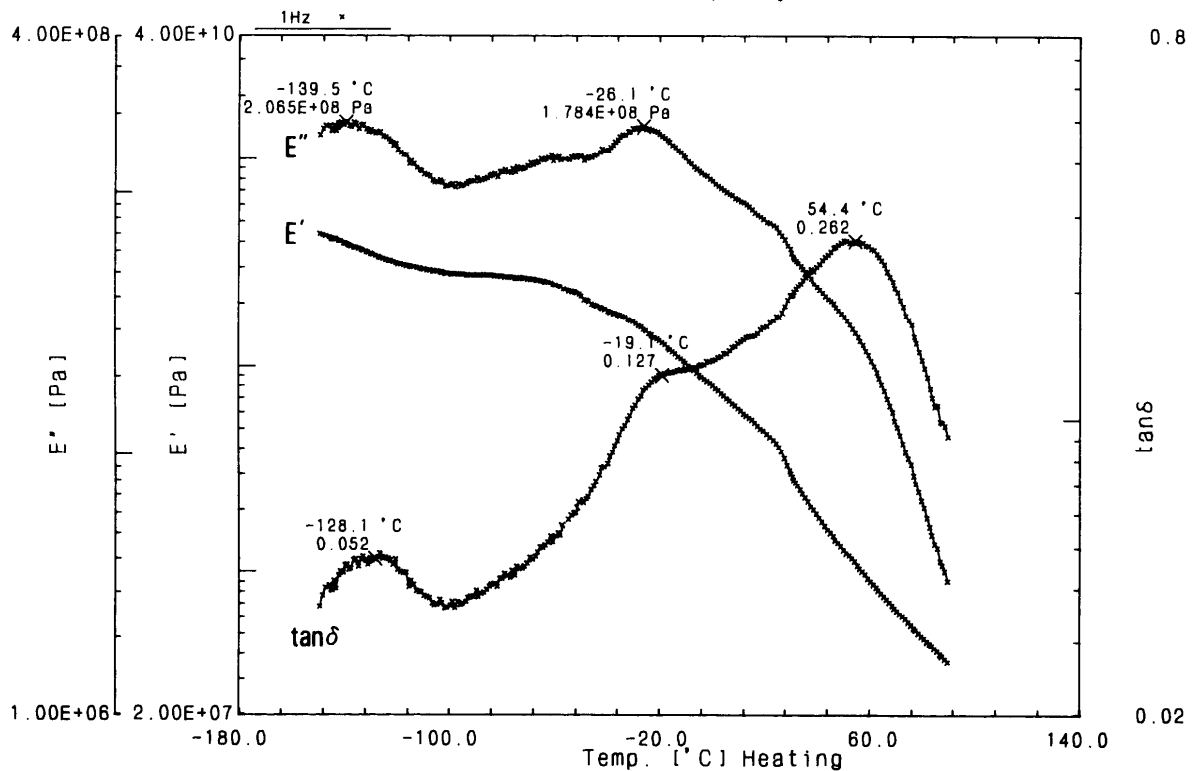
DMS

Name: Sample: LDPE
 Date: 89/04/16 14:41 Temp. mode: Ramp
 Comment: 1°C/min Deform: Flexure rec.
 1*w*t: 20.000* 12.050* 1.700 mm
 Frequency: 0.5 ~ 10 Hz



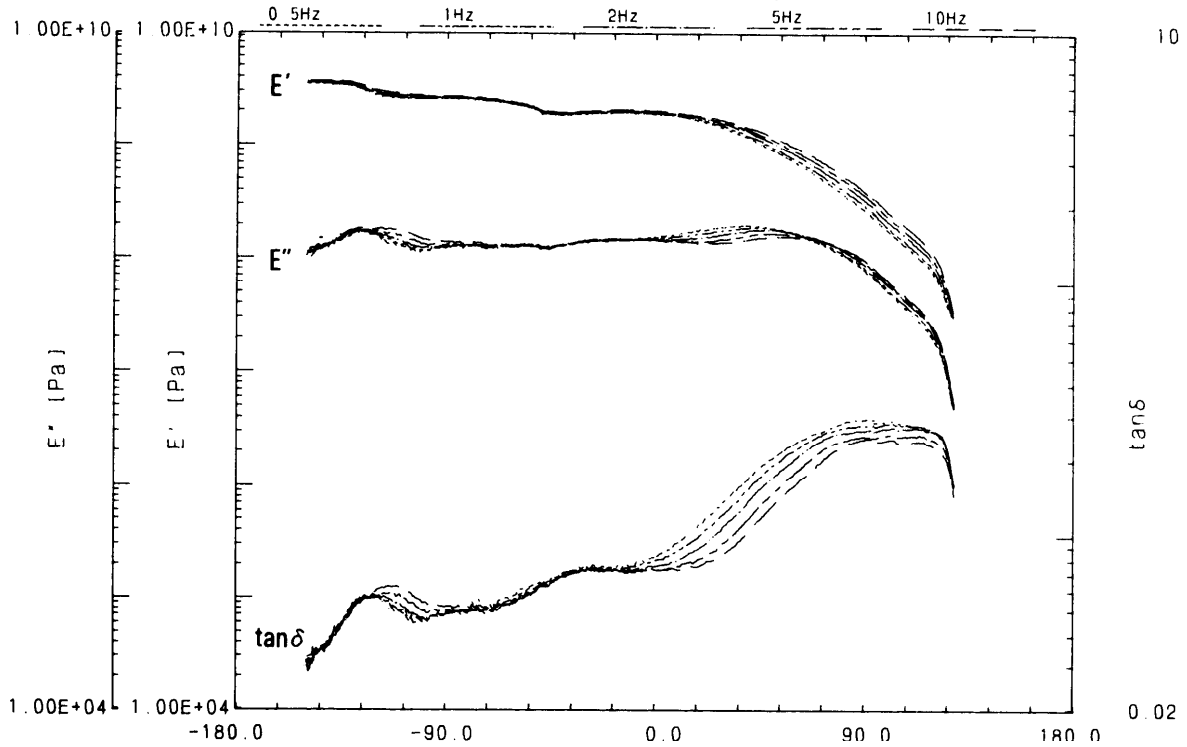
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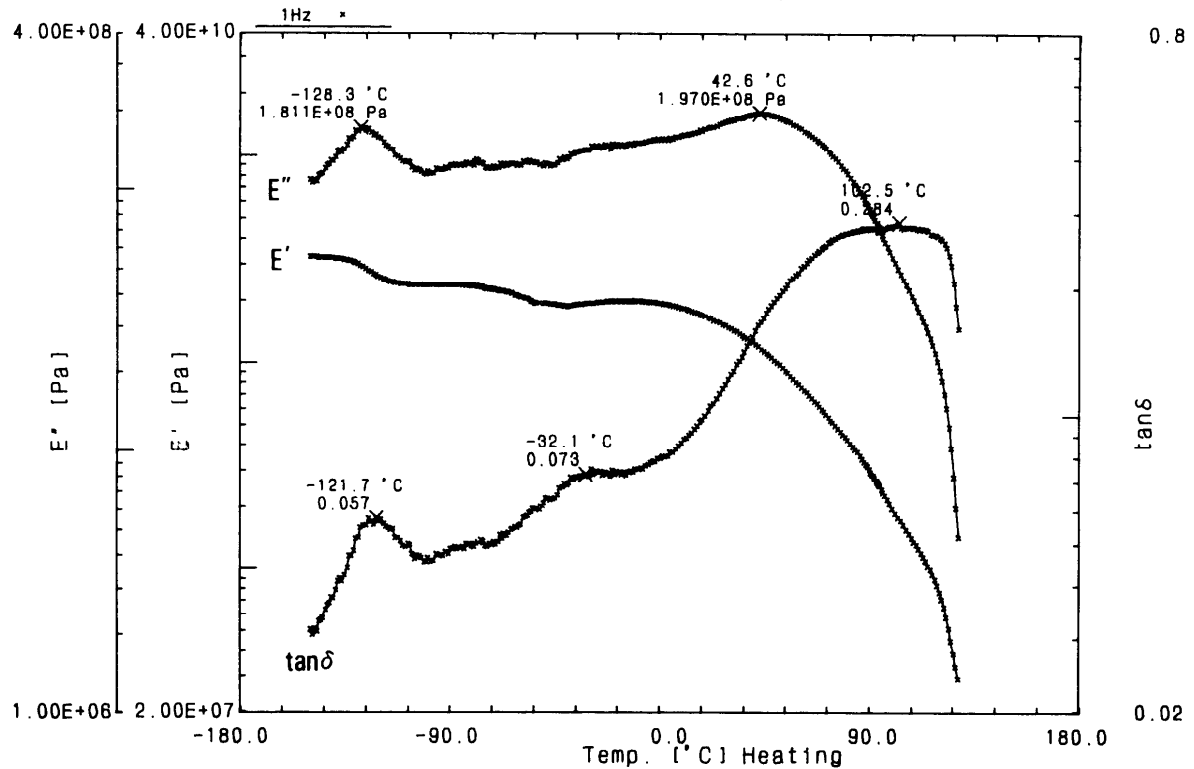
DMS

Name		Sample	HDPE
Date	89/04/15 20:28	Temp mode	Ramp
Comment	1°C/min	Deform	Flexure rec
	-----	l*w*t	20.000* 6.450* 2.220 mm
	-----	Frequency	0.5 ~ 10 Hz



DMS

Name:		Sample:	HDPE
Date:	89/04/15 20:28	Temp. mode:	Ramp
Comment:	1°C/min	Deform:	Flexure rec.
	-----	l*w*t:	20.000* 6.450* 2.220 mm
	-----	Frequency:	0.5 ~ 10 Hz



• **Comparison of $\tan\delta$ curves for LDPE and HDPE**

Three dispersions are present in the LDPE data from the high temperature side: α , β , and γ . The α dispersion is attributed to crystal relaxation, the β dispersion is attributed to the main dispersion (glass transition) of the amorphous portion and the γ dispersion is attributed to the local mode relaxation of the amorphous portion. In the HDPE data, an α' dispersion is present, in addition to the three previously mentioned dispersions. This α' dispersion is attributed to the grain boundary relaxation.

The figure below compares the $\tan\delta$ curves of the low and high density polyethylene measurement results. The β dispersion peak of the HDPE is lower than that of the LDPE. Furthermore, the α dispersion peak for the HDPE is at a higher temperature. These results are likely due to the following reasons. High density, highly crystallized polyethylene has little main chain branching and a lower amorphous component than LDPE. This results in a lower β dispersion, which is caused by glass transition. Conversely, due to the high amount of crystal lamellae in high density polyethylene, the α dispersion (crystal relaxation), which appears along with the α' dispersion (grain boundary relaxation), is at a higher temperature.

