

Explore the orientation dynamics of polymer chain segment



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Introduction

Motion of the polymer chain segments directly affect the performance of polymer materials, the current detection methods can only observe relaxation time but can not directly observe relaxation process of the chain segments, due to the polymer chain segments size is small, fast and irregular motion.

We try to indirectly observe polymer chain segment movement. Select planar molecule as the probe molecule uniformly doped into polymer system, take the motion of probe molecule with polarized infrared light, reflected the polymer chain segment of the relaxation process through the probe molecule in the forced movement.

Methods

Infrared polarized light intensity with time after transmitted through the sample after, and light intensity fluctuation is very small compared to itself, the time of fluctuation is very short, no direct detection processing, so we use the correlation function for signal processing. According to the properties of the self correlation function, we can extract the intensity fluctuation. The autocorrelation function is a measure of the average characteristics of the signal in the time domain, which is used to describe the dependence of values in a time signal and another time value.



Figure 1 Autocorrelation function of two typical signal

Selection of the probe molecule: 1-BenzaldehydeAzine, $C_{14}H_{12}N_2$, rotationally symmetric angle is 180° , $1626cm^{-1}$ is C=N vibration of contraction. Tris(2,3-dibromopropyl) isocyanurate $C_{12}H_{15}Br_6N_3O_3$ rotationally symmetric angle is 120° , $1698cm^{-1}$ is C=O vibration of contraction.

Selection of the polymer: aPS, glass transition temperature $100^\circ C$, no significant absorption between $1590-2500cm^{-1}$.

Experiments and data

Sample processing: Use chloroform as the solvent, mixed sample by solution casting method, adopted high temperature pressure film sample preparation in $110^\circ C$, configure different proportions of the sample.

The serial number	aPS	Benzaldehyde Azine	Mass ratio	Sample thickness
A	5g	0.015g	1000:3	85um
B	5g	0.1g	50:1	78um
C	5g	0.5g	10:1	45um

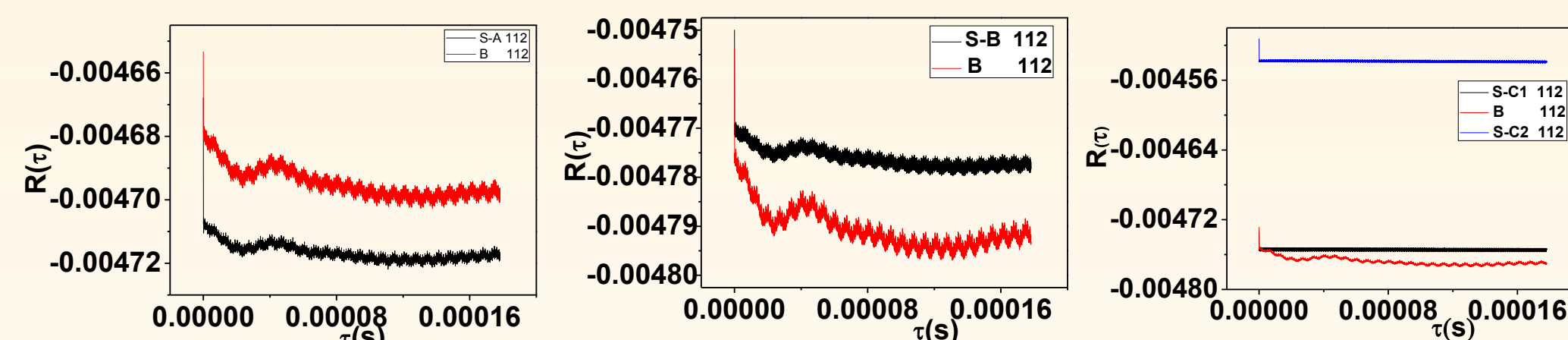


Figure II: Different proportions of the three sample groups of related functions at the same temperature at $1626cm^{-1}$.

Figure III :B sample correlation function at different temperatures at $1626cm^{-1}$.

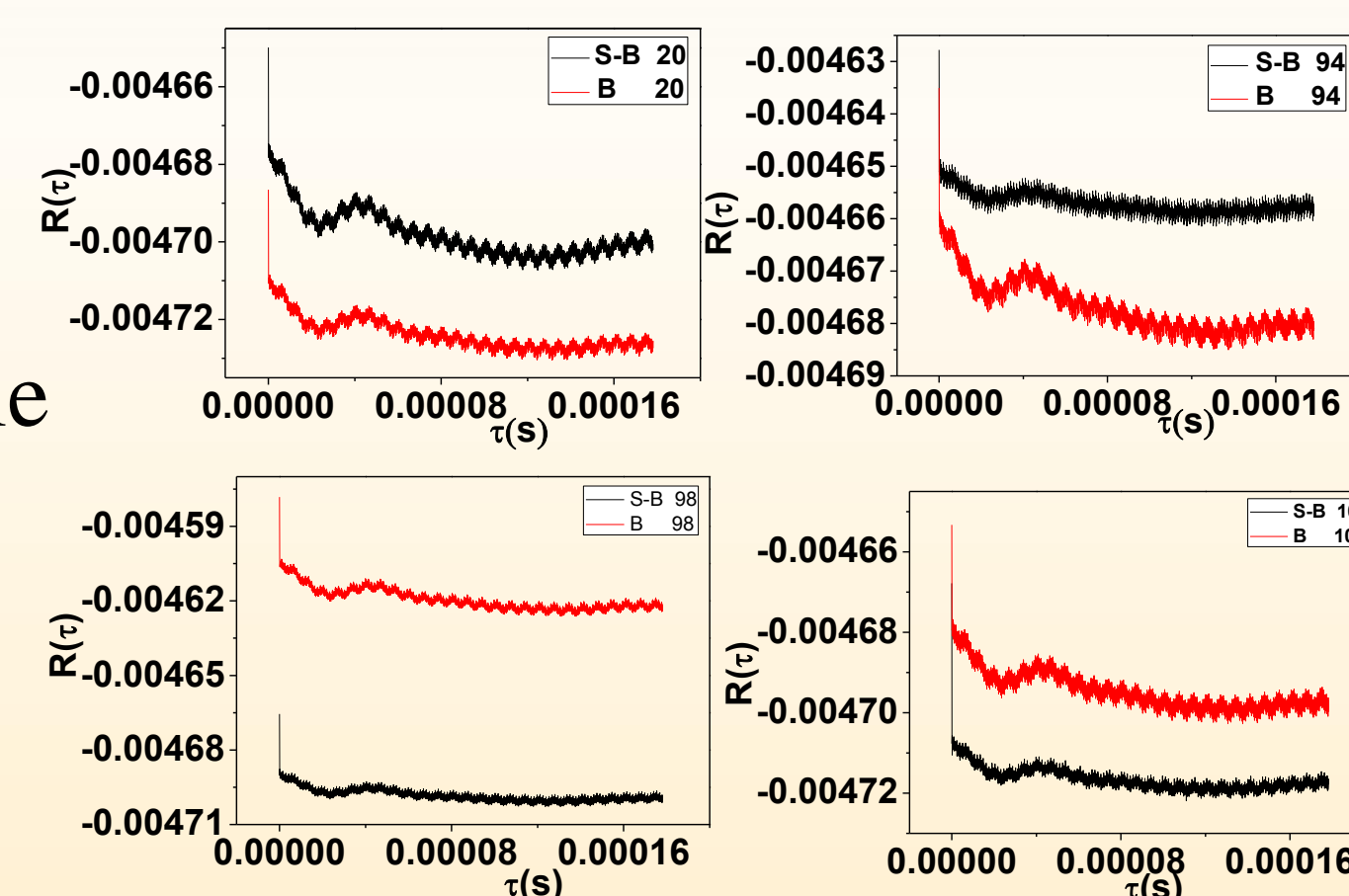
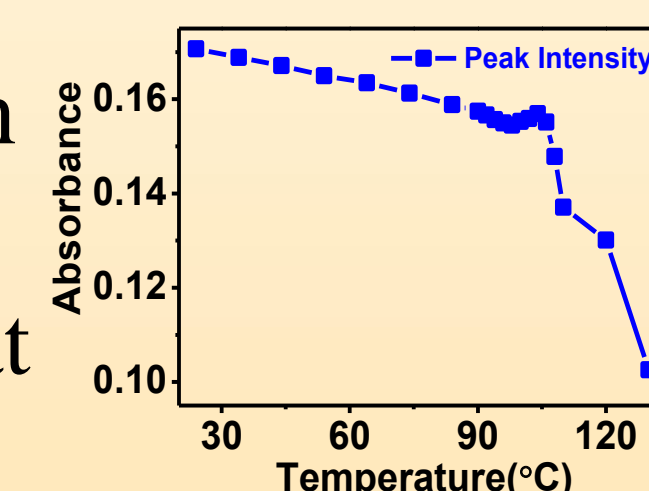


Figure IV :B samples were stretched in $120^\circ C$ under two strain, the polarized absorption variation with temperature at $1626cm^{-1}$.



Discussion and Conclusion

According to the basic properties of the self correlation function, we can get the incident light is similar to the sine wave and volatility decreases with the probe molecules increased from figure II.

From Figure III, we can see that the molecular motion increases with increasing temperature, result in enhanced absorption of volatility.

Figure IV prove that the temperature rise, the probe molecule motion increases due to the polymer chain segment movement.

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