

## The Effect of Sol-Gel Transition of Poly (Vinyl Chloride) Gel on Stress Relaxation Behavior

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### 1. Introduction

The PVC/plasticizer gels are generally classified as randomly cross-linked networks of flexible PVC strands, and the PVC crystal domains work as the cross-linking sites. PVC forms physical gels in various solvents, and the structures and physical properties of these gels have been extensively investigated for low PVC concentration system. However, commercial PVC compounds are generally used for rigid and flexible applications with high PVC concentration. It has been reported that these PVC compounds have a microcrystalline structure whose melting range is about 120–210 °C and can extend to somewhat higher temperatures. Rheology properties have been reported for stress relaxation properties of the low PVC concentration system<sup>(1)</sup>. Damping function is important for understanding the nonlinear viscoelastic behavior of polymer melt. But it is a few report. This study focuses on the damping function and nonlinear rheological properties of a PVC/DINP under large step strain.

### 2. Experiment

The stress relaxation after step strain behavior of PVC/di-isononyl phthalate (DINP) having PVC content of 45.5 wt% was examined. The critical gel temperature ( $T_{gel}$ ) of this sample has been reported to be 190 °C. Rheological measurements were carried out with a rotational rheometer (MCR, Anton Paar). The nonlinear relaxation modulus  $G(t, \gamma)$  is measured under step strain of  $\gamma = 0.1-5$ , respectively. The damping function  $h(\gamma) = G(t, \gamma) / G(t)$  was obtained from non-linear relaxation modulus which was factorable into time and strain-dependent functions.

### 3. Results and Discussion

Figure 1 shows  $h(\gamma)$  of 180, 190, 200 °C.  $h(\gamma)$  is known to be a function dependent on the polymer structure. PVC / DINP system at 180 °C shows little dependence on strain and behaves like gel similar to the behavior of crosslinked rubber. Because PVC crystal domain plays the same role as the chemical cross-linking network structure. The strain dependence of  $h(\gamma)$  at 200 °C,  $h(\gamma)$  shows the strong strain dependence, though it is still higher than that of D.E theory for linear mono-disperse polymer.

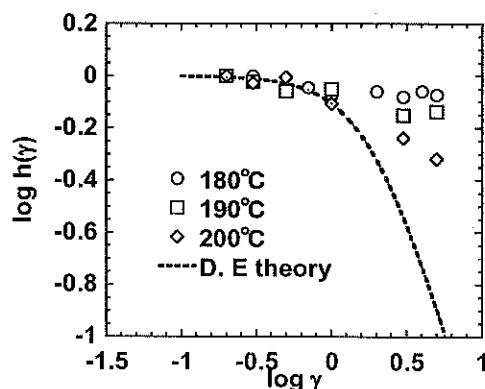


Fig.1 Strain dependence of damping function for PVC/DINP

[1] H. Watanabe, T. Sato, K. Osaki, Y. Aoki, L. Li, M. Kakiuchi, M-L. Yao, *Macromolecules*, **31**, 4198-4204 (1998)