

## Poly(vinyl alcohol)/ Sodium Alginate 블렌드의 제조 및 특성

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## Preparation and Characterization of Poly(vinyl alcohol)/ Sodium Alginate Blend

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### 1. Introduction

Polymer blending constitutes a most useful method for the improvement or modification of the physicochemical properties of polymeric materials. Some of the polymer blends exhibit unusual properties, unexpected from homopolymers. An important property of a polymer blend is the miscibility of its component, because it affects the mechanical properties, the morphology, its permeability and degradation [1, 2].

Poly(vinyl alcohol)(PVA) finds well-established applications in textile, biomedical technology, paper, and coating industries. Additional interest in PVA has recently arisen because of the special features exhibited by its aqueous solutions, as well as by aqueous admixtures of PVA with other macromolecules consisting in the formation of stable physical gels following freezing-thawing cycles[3]. PVA has flexible main chain, while sodium alginate(SA) has a very rigid six-membered ring structure on the backbone. Also sodium alginate is soluble in water, has carboxylate groups, and is biodegradable. Alginates are used in various application such as thickening agents, emulsifiers, stabilizers, encapsulation, or used to form gels and films. Among alginate's characteristics, its gelation behavior is unique. Since alginate is biodegradable and its sodium salt is soluble in water, it was expected that it can be used as a substitute for acrylic acid polymers, without environmental problems.

In this work, sodium alginate was selected for blending with PVA because the rigidity and bulkiness of material is not only easy to destroy close molecular

packing and high degree of crystallinity of PVA but also good to increase viscosity of blend solution after gelation. We investigated a different method to prepare gels by freezing-thawing method have shown many improved properties over hydrogels prepared by traditional chemical crosslinking techniques and properties of blend solutions, and their films with various composition(in weight percent)[4].

## **2. Experimental**

### **2.1. Materials**

Poly(vinyl alcohol)(PVA) powder was purchased from Aldrich Chemical Co.. The weight average molecular weight of the PVA was 124,000. The average degree of saponification was 98-99%. Sodium alginate (SA, chemical grade) powder was purchased from Aldrich Chemical Co.. The viscosity of SA is 200-400 cps. All two were used without further purification.

### **2.2. The preparation of samples and gelation of solution**

Solid content of blend (poly(vinyl alcohol)/ sodium alginate) solution fixed 5 wt%. The solution was prepared by uniformly mixing together with various composition. Pouring the aqueous solution on to the Teflon formed the solution-cast films and subsequent drying at 50°C for 3-4 days. Films were examined after casting.

In this work, we used freezing-thawing method to prepare gels instead of chemical gelation. The freezing-thawing method promotes a entanglement between molecules of poly(vinyl alcohol) and sodium alginate. This differs from traditional crosslinking method that include toxic agents and decrease the biocompatibility of the resulting biomaterial. Gels were prepared with repeating cycles of freezing at -18°C for 6-10 hours and thawing at 25°C for above 12 hours.

### **2.3. Characterization**

Brookfield Viscometer (Brook LVDV-II+ Programmable Viscometer, U. S. A) and ARES Rheometry (Rheometric Scientific Ltd., U. S. A) were used to measure the viscosity of poly(vinyl alcohol)/ sodium alginate blend solutions and their gels. The morphology of blend films were observed by a Scanning Electron Microscope (HITACHI S-4200). Differential Scanning Calorimeter (SSC/5200H MII, Seiko Ins.) used to determine the thermal transitions of polymer blend.

## **3. Results and Discussion**

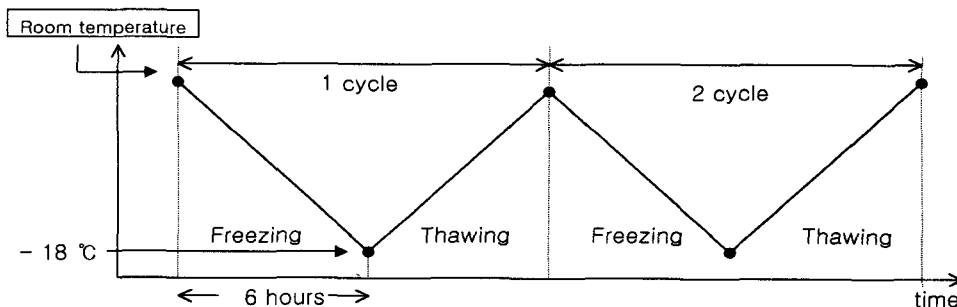
Sample designation and gelation conditions of aqueous PVA/SA are shown Table1. Figure 1 shows the gelation conditions of aqueous PVA/SA. We used freezing-thawing method to prepare gels instead of chemical gelation. It was found that the gelation was depended on the blend ratio of PVA/SA (see Table I).

For example, the 1 cycle sample PS73-1c was in the mixture state of sol/gel, however, PS73-2c sample was gelled completely.

**Table I.** Sample designation and gelation conditions of aqueous PVA/SA(solid content : 5 wt%)

Blend ratio PVA : SA	Untreated Sample	Treated Samples	
		1cycle(freezing-thawing) of gelation	2cycle(freezing-thawing) of gelation
10:0	PVA	PVA-1c	PVA-2c
9:1	PS91	PS91-1c	PS91-2c
7:3	PS73	PS73-1c	PS73-2c
5:5	PS55	PS55-1c	PS55-2c
3:7	PS37	PS37-1c	PS37-2c
1:9	PS19	PS19-1c	PS19-2c
0:10	SA	SA-1c	SA-2c

The viscosity of all samples increased with increasing the number of cycle (freezing-thawing). Figure 2 shows viscosity vs. shear rate for samples PS73 and PS73-2c. The freezing-thawing treated PS73-2c has a higher viscosity than that of untreated PS73 in the low shear rate region. Figure 3 shows the rheological behavior of the typical sample PS73. In case of solution state for sample PS73, the loss modulus  $G''$  value was higher than storage modulus  $G'$  value. However, in case of freezing-thawing treated samples PS73-1c and PS73-2c, its  $G'$  was higher than  $G''$  in the low frequency region. This is due to the crosslinking of polymer molecules by gelation. The cross point of  $G'$  and  $G''$  was shifted to higher frequency with increasing the number of cycle. This indicates that the gelation increased with increasing the number of cycle.



**Figure 1.** The gelation conditions of aqueous PVA/SA

(Gelation condition of aqueous PVA/SA : freezing temperature (°C) : -18, freezing duration (h) : 6, thawing temperature (°C) :  $25 \pm 1$ , thawing duration (h) : above 12).

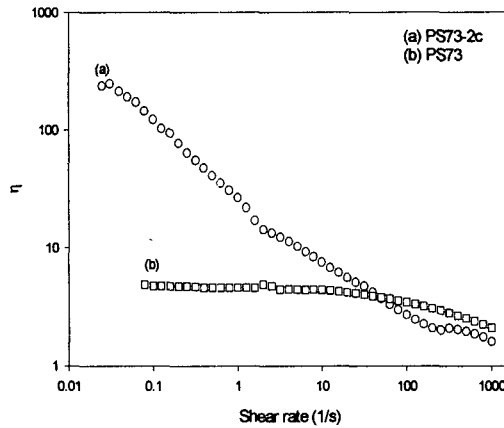


Figure 2. Viscosity vs. shear rate for samples PS73 and PS73-:

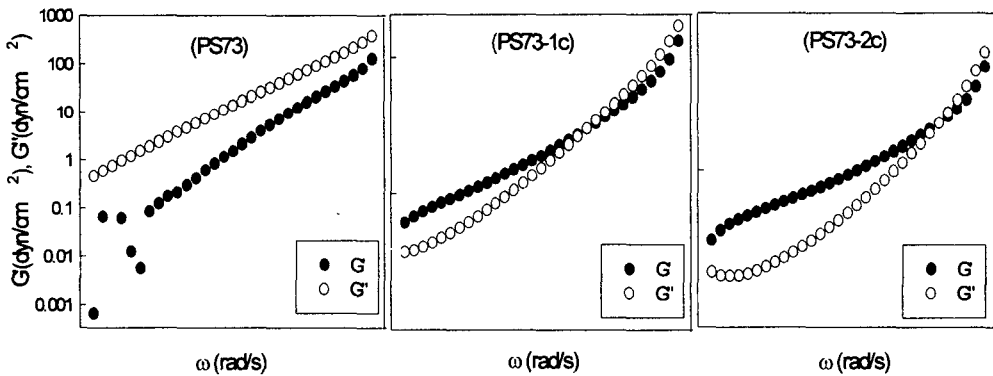


Figure 3. The rheological behaviors of typical sample PS73 sample

#### 4. Reference

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