Thermal Characterization of Gelation for Aqueous Methylcellulose Solutions Containing Polyethylene Glycol and Salt

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Introduction

Methylcellulose (MC) and Polyethylene Glycol (PEG) are considered to be environmentally and biologically compatible materials, and they have been applied to industrial and biological uses as highly hydrophilic and viscous polymers. The gelation temperature of aqueous MC solutions is reduced by addition of PEG and/or salt [1]. To evaluate thermal characteristics, DSC can be used to measure gelation temperature. However, these measurements often were difficult to detect gelation peak in low concentration solution from aspect of DSC sensitivity.

In this study, we investigated the influence of PEG and/or salt on MC hydrogel formation using high sensitivity DSC and the large volume low-pressure sealed pan [2].

Attempt to detect the gelation peak of low concentration MC hydrogel using DSC7000X. Then investigate the following:
1. Influence of salt addition. 2. Influence of PEG addition.3. Difference of influence of the kind of salt.

Samples and Measurement method

Samples

- **Methyl Cellulose 400** (Mw=84000, Molar fraction: 0.001)
- **Polyethylene Glycol 6000** (Molar fraction of Ethylene oxide unit: 0.02, 0.03)
- **$MgCl_2$** (0.1 moℓ/ℓ)
- **$CaCl_2$** (0.1 moℓ/ℓ)

Measurement Conditions

- **Apparatus : High Sensitivity Differential Scanning Calorimeter DSC7000X**
- **Temperature range : R.T. to 100 ºC**
- **Heating rate : 4 ºC/min**
- **Sample weight : 40 mg**
- **Sample pan : Chromated Aluminum Low-pressure sealed pan**

DSC7000X
High Sensitivity Differential Scanning Calorimeter

Low- Pressure Aluminum pan
Chromate coating was treated to resist a reaction with the water.

Results

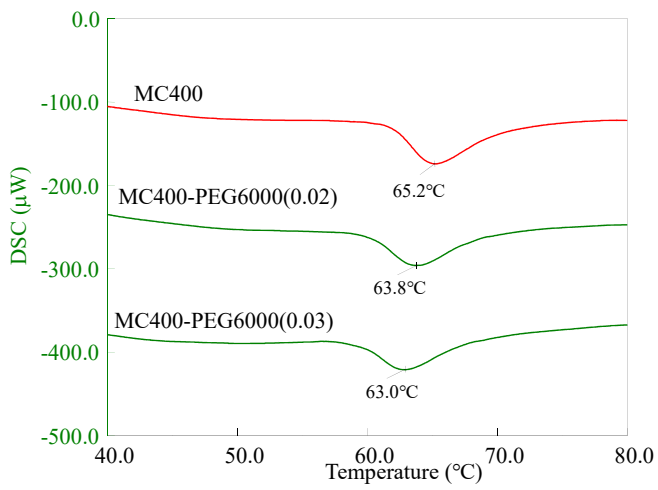


Fig. 1 Influence of PEG

$MgCl_2$ or $CaCl_2$ decrease the gelation peak temperature. The effect of $CaCl_2$ on gelation temperature is larger than that of $MgCl_2$.

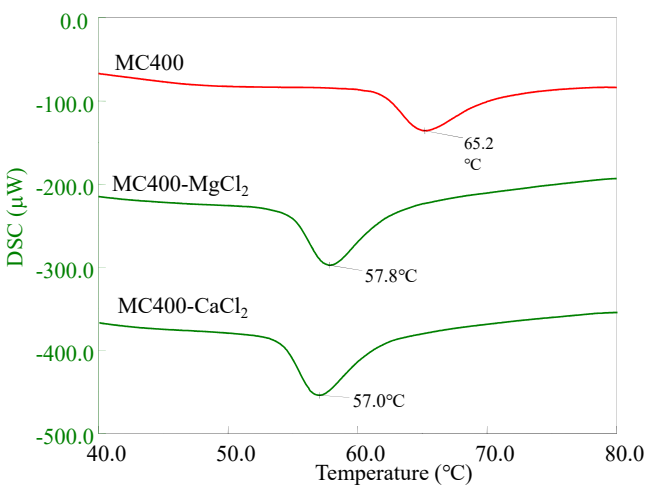
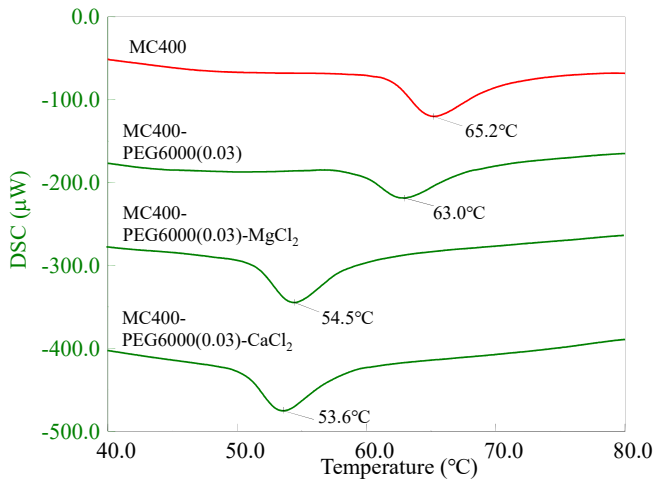


Fig.2 Influence of salt

Addition of PEG reduces the gelation peak temperature.

Added salt



Added PEG

Fig. 3 Influence of PEG and salt

PEG decreases the gelation temperature. When both PEG and salt are added, gelation temperature decreases dramatically.

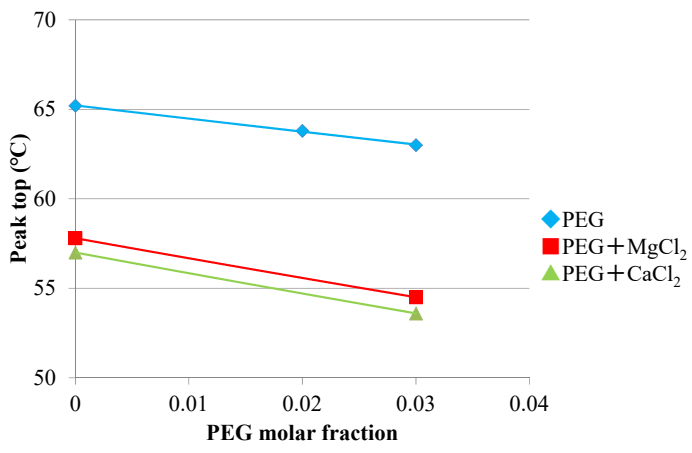


Fig. 4 Effects of PEG and salt

Effects of salt and PEG addition on gelation temperature of MC hydrogel.

Summary and Conclusion

We used a low-pressure pan with large volume to detect gelation peaks clearly :
1. $MgCl_2$ and $CaCl_2$ decreased the gelation temperature.
2. The peak temperature decreased with addition of PEG.
3. The effect of $CaCl_2$ on gelation temperature is larger than that of $MgCl_2$.

Reference

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[2] Y.Uehara, E. Shimoda, Y. Iitaka, and Y. Nishimoto, *Trans. Mater. Res. Soc. Jpn.*, 2013, *38*, 589.