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Dielectric response of gels containing cellulose ether polymers

C. B. MCCRYSTAL, J. L. FORD, R. HE*, D. Q. M. CRAIG* AND A. R. RAJABI-SIAHBOOMI

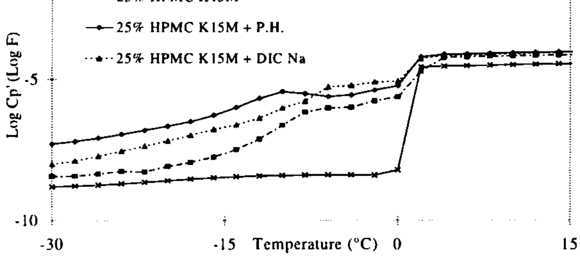
*School of Pharmacy and Chemistry, Liverpool John Moores University, Liverpool L3 3AF, and *School of Pharmacy, University of London, 29-39 Brunswick Square, London WC1N 1AX*

The interaction of water with non-ionic cellulose ethers, which are used in hydrophilic matrices, plays an important role in polymer hydration and gel formation. Formation of a barrier gel layer is critical in controlling drug release (Melia 1991). Detailed analysis on the types of water existing within the gel layer are fundamental to the understanding of the mechanism of drug release and the factors that may affect it. Distinctive thermal events have been identified in DSC scans of hydroxypropylmethylcellulose (HPMC) gels. They were dependent on polymer viscosity grade, substitution type, gel concentration and drug (McCrystal et al 1997). In this study, the interactions between water and cellulose ethers were studied using dielectric spectroscopy.

HPMC Methocels K100LV, K4M, K15M, K100M, E4M, F4M and Methylcellulose (Methocel A4M) were obtained from DOW Chemicals, USA. Gels concentrations of 2 - 25% w/w were prepared and stored at 4°C for 24h. HPMC K15M (25% w/w) gels were prepared in the absence and presence of 50mM propranolol hydrochloride [P.H.] or diclofenac sodium [DIC Na]. Dielectric analysis was carried out on a Novocontrol GmbH spectrometer with an attached QUATRO temperature controller. Gel dielectric response was recorded at -30, 0 and 22°C over a frequency range of 10^{-2} to 10^{+7} Hz and over a temperature range of -30 to +20°C at a constant frequency of 1 Hz.

The dielectric responses of 25% w/w HPMC K15M gels and deionised water were similar at +22 and 0°C. However at -30°C, a dielectric response typical of a solid was apparent. The melting of frozen water within gels was detected as increases in the magnitude of the dielectric response with increase in temperature. More than one phase transition was visible in the majority of

Fig 1: Log Cp' (Log Capacitance) against temperature for HPMC K15M gels in the absence and presence of drugs at a frequency of 1Hz



gels studied which may be related to the presence of different types of water melting at different temperatures. In addition to polymer concentration, both polymer molecular weight and substitution level influenced the nature of the transitions. Drug addition affected the transitions occurring during the melting of ice in the gels (Figure 1). The magnitude of the dielectric response was increased in all HPMC gel systems in comparison to the response seen in deionised water. This may be related to the presence of ionic species in the systems.

The results of dielectric studies are in agreement with previous studies using thermal analysis techniques (McCrystal et al 1997) where small transitions were visible on the low temperature side of the main endotherm for the melting of free water. Such low temperature transitions, by DSC and in the dielectric repsonse reported here, may be related to the presence of different types of water which may exist within the gels.

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