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Dielectric spectroscopy of polyvinyl alcohol cryogels

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Gels based on polyvinyl alcohol (PVA) can be formed by repeated freezing and thawing of a solution of the polymer. PVA cryogels have applications as biomaterials, including artificial tissue and drug delivery systems. The mechanical and electrical properties of polymeric materials can be changed significantly by adding a small amount of nanometer-sized particles. In this work, the dielectric properties of PVA solutions and gels were studied in the frequency range from 10 muHz to 1 MHz as a function of temperature, using a dielectric spectrometer. Comparison of the dielectric constant of a PVA solution to that of water indicates that –OH groups on the polymer make a large contribution to the dielectric response above 273 K. The real and imaginary parts of the dielectric constant ε decrease during the cooling phase of a freeze-thaw cycle due to a reduction in the mobility of the dipoles and do not completely recover on thawing. Similarly, a relaxation peak in ε' for the PVA gel moves to lower frequency as the temperature is decreased due to a slowing of the relaxation process. We interpret these results in terms of the structural changes that take place within the PVA gel in the process of gel formation. We also investigate the effect of incorporating a small concentration of multi-walled carbon nanotubes into the cryogels.

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