

Determination of the Viscoelastic Properties of Hydrogels based on Polyethylene Glycol Diacrylate (PEG-DA)

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Artificial hydrogels offer several advantages for use in biomedical engineering: Their mechanical properties can be adjusted over several orders of magnitude by changing the network density and the solvent concentration. Their open network is accessible for an outside culture medium and their functional properties can be tuned by the utilized base monomer and crosslinker.

In this work a systematic study of the viscoelastic properties of hydrogels based on polyethylene glycol diacrylate (PEG-DA) is presented. A mixture of PEG-DA and the organic solvent PEG400 (solvent contents varied between 15-55 weight%) was thermally cured. Afterwards the organic solvent was exchanged by water to get a hydrogel. Specimens were compression tested under static and dynamic load. Besides this, instrumented indentation tests with different indenter geometries (cylindrical, spherical) and load ranges (macro and nanoindentation) were carried out. Shear tests (plate-to-plate geometry) and relaxation tests were applied for moduli (short and long-term) and relaxation time calculation. Geometrical effects were analyzed and the results obtained with the different measuring techniques were correlated to each other.

The measured elastic moduli of the evaluated hydrogels range over three decades from about 30kPa to 10MPa. Shear tests and nanoindentation did not provide consistent values. Whereas compression tests yield reproducible values for the viscoelastic properties at the expense of elaborate sample preparation. Macroindentation with spherical indenter turned out to be the technique with the lowest demand regarding sample preparation. At the same time the measured mechanical properties are consistent for the investigated materials and sample geometries. Since the measured elastic moduli typically vary between 20-30% depending on the utilized measurement technique mechanical properties of hydrogels should always be stated together with the measurement technique used to obtain them.

Paper confirmed for MSE-Congress 2008 for Symposia: D11: (Mechanical Testing (1st) and A17: Biological and Bioinspired Materials (2nd))