Method for independent strain and temperature measurement in polymeric tensile test specimen using embedded FBG sensors - DTU Orbit (08/11/2017)

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A novel method to obtain independent strain and temperature measurements using embedded Fibre Bragg Grating (FBG) in polymeric tensile test specimens is presented in this paper. The FBG strain and temperature cross-sensitivity was decoupled using two single mode FBG sensors, which were embedded in the specimen material with a certain angle between them. It is demonstrated that, during temperature variation, both FBG sensors show the same signal response. However, for any applied load the signal response is different, which is caused by the different levels of strain acting in each sensor. Equations to calculate independently the strain and temperature are presented in the article, together with a measurement resolution study. This multi-parameter measurement method was applied to an epoxy tensile specimen, tested in a unidirectional tensile test machine with a temperature controlled cabinet. A full calibration procedure (temperature and strain) was performed to this material-sensor pair, where a calibration error < 1% was achieved. This was followed by a strain-temperature test case, where multiple two loading/strain stages of ε = 0.30% and ε = 0.50% were applied during a continuous variation of temperature, from 40 C to -10 C. The consistency of the expected theoretical results with the calibration procedure and the experimental validation shows that this proposed method is applicable to measure accurate strain and temperature in polymers during static or fatigue tensile testing. Two different calibration protocols are presented and analysed.

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