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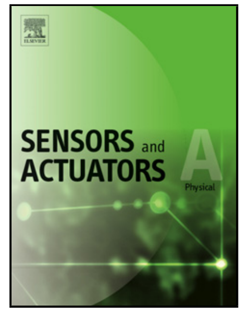

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Mechanical and electrical characterization of quartz tuning fork force sensors

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The results of a systematic experimental characterization of the mechanical and electrical properties of quartz tuning forks (QTFs) are presented. Actuation efficiency and detection sensitivity are introduced as parameters for characterization of the QTF with a focus on their use as a force sensor. The spring constants, quality (Q) factors, actuation efficiencies and detection sensitivities of twelve QTFs were measured by combining heterodyne interferometry with an electrical excitation/detection set-up and found to be consistent for all twelve QTFs. Spring constants were determined using geometrical and thermal methods and were found to agree within 3 %. The Q-factor, actuation efficiency and detection sensitivity of the QTFs were measured for the first two vibrational modes. The Q-factor and detection sensitivity were higher in the second vibrational mode while the actuation efficiency was lower. We show that the QTF displacement amplitude can be determined from the detection sensitivity and the measured current through the QTF. The performance of a QTF as a force sensor is discussed based on a comparison of the mechanical and electrical parameters measured for the first and second vibrational modes. The results are relevant for QTFs used in sensing applications, especially as force sensors in scanning probe microscopes.

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