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Effects of materials conductivity on the viscosity measurement using a QCM

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Quartz crystal microbalance (QCM) is commonly used to characterize the viscosity of soft materials. For biomedical applications the modified BVD model of QCM is unsuitable due to the conductivity of the biomaterial. In order to take into account the electrical effects, a new model including a static lossy capacitor is proposed. A theoretical study of the shear wave propagation in the quartz shows that these effects modify the static and the motional branches of the BVD circuit. The conductivity effects of the material at the surface of the QCM can be modelled by same parallel elements added in both branches. In the motional branch the electromechanical coupling factor is applied to these elements. To validate the new lumped element model measurements for KCl mixtures are achieved. The results show that an accurate extraction of viscosity (<5%) can be obtained for a middle of conductivity less than 0.3 S/m. In addition for water/glycerol mixtures the resonant frequency shift and damping follow an accurate linear shape (<5%) according to the square root of the liquid viscosity and density product. These results increase (up to 200 times) the validity domain of viscosity compared to the classical modified BVD model.