SUPPORTING INFORMATION

VISCOELASTIC CHARACTERIZATION OF BENZO-CROWN ETHER FUNCTIONALISED ELECTROACTIVE FILMS

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Theory for acoustic resonator responses of individual physical components

Previous work quantifies the surface mechanical impedance contributions of individual components of the electrochemical system\(^1\text{-}^3\). That for a semi-infinite Newtonian fluid (the electrolyte solution) is defined by its density \((\rho_s)\) and viscosity \((\eta)\): 

\[
Z_L = \left( \frac{\omega \rho_s \eta}{2} \right)^{1/2} (1 + j) \quad (S1)
\]

The contribution for a “rigid” (strictly, acoustically thin) mass layer, is defined in terms of the mass per unit area (areal density, \(\rho_m\)) and resonator angular frequency \((\omega)\): 

\[
Z_m = j\omega \rho_m \quad (S2)
\]

For a viscoelastic film, the contribution is expressed in terms of its thickness \((h_f)\), shear modulus \((G)\) and density \((\rho_f)\): 

\[
Z_f = (G\rho_f)^{1/2} \tanh(\gamma h_f) \quad (S3)
\]

where the shear modulus comprises real and imaginary components: 

\[
G = G' + jG'' \quad (S4)
\]

associated with energy storage and loss, and the wave propagation constant: 

\[
\gamma = j\omega(\rho_f / G)^{1/2} \quad (S5)
\]

The decay length of the acoustic wave within the film: 

\[
\delta = \frac{1}{\omega \sqrt{\rho_f}} \sqrt{2|G| \over 1 - G'/G} \quad (S6)
\]

When \(h_f > 2\delta\), there is negligible acoustic displacement at the outer film interface. The film is described as semi-infinite and the resonator response is insensitive to \(h_f\). The hyperbolic tangent in Eqn. (S3) approaches unity and the film impedance reduces to a material (thickness independent) property, the characteristic mechanical impedance: 

\[
Z_0 = (G\rho_f)^{1/2} \quad (S7)
\]
**Figure S1:** Admittance spectra acquired during the polymerisation of [Ni(3-Mesalophen-b15-c5)], *film B*. Scan rate: 20 mV s\(^{-1}\). — Bare quartz/Au in deposition solution; — quartz/Au/polymer at the end of successive deposition cycles (arrow indicates time sequence).
Figure S2: Analysis of acoustic resonator response during polymerisation of [Ni(3-Mesalophen-b15-c5)], to form films A (■) and B (●). Panel a: variation of resonant frequency change (with respect to that of bare electrode in solution) with deposition charge ($Q_{dep}$). Lines are least squares fits. Panel b: variation of resonant admittance with resonant frequency change.
Figure S3: AFM images used to estimate $h_f$ at cut edges of films E (panel a) and F (panel b).
References


