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**Electrode-side impedance nonlinearity in polycarbazole bioelectrodes quantifiable by a quaternion formalism** M. OVADIA, D.H. ZAVITZ, UIC, Y.P. KAYINAMURA, J.F. RUBINSON, Georgetown — Nonlinear response to sinusoidal electrification is a phenomenon rarely observed for conductive interfaces. We report nonlinear response as an electrode phenomenon in a conjugated polymer electrode polycarbazole. While other semiconductors manifest an impedance quantifiable in the complex field (*e.g.* Warburg where complex Z = $Z_{W\infty}$ and resistive with Z = $Z_{Hl}$ [Hl-Halbleiter]) the polycarbazole manifests no definable impedance due to essential nonlinearity. There is no description available for this form of pseudoconductivity. We introduce a quaternion formalism $Z_{\subset T}$=a+bi+cj+dk [where a,b,c,d are real and $i^2$=$j^2$=$k^2$=-1 and jk=i] that successfully describes all conductivity (c=d=0) and pseudoconductivity presently known as a normed ring, and reduces to the complex field for conductivity. In this formalism, the normalized impedance of a capacitor is Z=i, the experimentally determined polycarbazole pseudoimpedance $Z_{\subset T}$=k, that of a resistance is Z=1 and that of the $Z_{W\infty} = \sqrt{i} = i^{1/2}$. The non-Abelian character of $Z_{\subset T}$ implies that the Onsager relation fails for some interfaces. Remarkably, certain Kramers-Kronig relations (Hilbert transformation in not only the complex but also the [j,k] plane) still hold for certain experimental setups. Computation of the energy integral $\int \mathbf{D}\cdot\mathbf{E}dt$ reveals that charge transport is lossless, similar to conduction in an ordinary capacitance.

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