A wavelet method for solving strongly nonlinear coupled problems in Li-battery

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During Lithium (Li) ion intercalation into or extraction out a solid electrode, the strong interaction between internal stresses and activation energy for diffusion can be described by strongly coupled differential equations with strong nonlinearity. To solve such equations, the modified wavelet Galerkin method developed earlier by the authors is used to discrete them in space, resulting in a set of nonlinearly coupled initial-value problems. Then based on the wavelet numerical integration technique, an implicit wavelet iteration algorithm is proposed to solve those initial-value problems. Results demonstrate that the present wavelet method is efficient and accurate enough to solve such strongly nonlinear coupled problems. For example, under fast charging, a steep gradient on the ion-concentration will appear close to the surface of the electrode, our proposed wavelet method even in a relative coarse "mesh" can capture this phenomenon while most classical finite element methods are not capable of doing this.

Keywords: strong coupling, nonlinear differential equations, wavelet Galerkin method, implicit wavelet iteration algorithm