Author's Accepted Manuscript

Model for Charge/Discharge-Rate-Dependent Plastic Flow in Amorphous Battery Materials

S.M. Khosrownejad, W.A. Curtin



 PII:
 S0022-5096(16)30146-6

 DOI:
 http://dx.doi.org/10.1016/j.jmps.2016.03.004

 Reference:
 MPS2831

To appear in: Journal of the Mechanics and Physics of Solids

Received date:15 July 2015Revised date:1 March 2016Accepted date:3 March 2016

Cite this article as: S.M. Khosrownejad and W.A. Curtin, Model fo Charge/Discharge-Rate-Dependent Plastic Flow in Amorphous Battery Materials *Journal of the Mechanics and Physics of Solids* http://dx.doi.org/10.1016/j.jmps.2016.03.004

This is a PDF file of an unedited manuscript that has been accepted fo publication. As a service to our customers we are providing this early version o the manuscript. The manuscript will undergo copyediting, typesetting, and review of the resulting galley proof before it is published in its final citable form Please note that during the production process errors may be discovered which could affect the content, and all legal disclaimers that apply to the journal pertain

Model for Charge/Discharge-Rate-Dependent Plastic Flow in Amorphous Battery Materials

S. M. Khosrownejad^{a,*}, W. A. Curtin^a

^aEPFL STI IGM LAMMM, 1015 Lausanne, Switzerland

Abstract

Plastic flow is an important mechanism for relaxing stresses that develop due to swelling/shrinkage during charging/discharging of battery materials. Amorphous high-storage-capacity Li-Si has lower flow stresses than crystalline materials but there is evidence that the plastic flow stress depends on the conditions of charging and discharging, indicating important non-equilibrium aspects to the flow behavior. Here, a mechanistically-based constitutive model for ratedependent plastic flow in amorphous materials, such as Li_xSi alloys, during charging and discharging is developed based on two physical concepts: (i) excess energy is stored in the material during electrochemical charging and discharging due to the inability of the amorphous material to fully relax during the charging/discharging process and (ii) this excess energy reduces the barriers for plastic flow processes and thus reduces the applied stresses necessary to cause plastic flow. The plastic flow stress is thus a competition between the time scales of charging/discharging and the time scales of glassy relaxation. The two concepts, as well as other aspects of the model, are validated using molecular simulations on a model Li-Si system. The model is applied to examine the plastic flow behavior of typical specimen geometries due to combined charging/discharging and stress history, and the results generally rationalize experimental observations.

Preprint submitted to Journal of the Mechanics and Physics of SolidsFriday 11th March, 2016

^{*}Corresponding author

 $[\]mathit{URL:}\ \mathtt{mostafa.khosrownejad@epfl.ch}\ (S. M. Khosrownejad), william.curtin@epfl.ch (W. A. Curtin)$

Download English Version:

https://daneshyari.com/en/article/7177691

Download Persian Version:

https://daneshyari.com/article/7177691

Daneshyari.com