Power Density and Reliability Correlations in $LiCoO_2$ 3D Laser-Structured Architectures

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The recent development of laser structuring of three-dimensional (3D) conical architectures (see Figure 1A) has led to an 80 times improvement in galvanostatic cyclability compared to its thin film counterpart [1]. To a first approximation, its main advantage resides in its shorter ion diffusion pathways and more efficient electrical transport. In this research, by using $LiCoO_2$ as the cathode chemistry, computer models based on finite element analysis are being developed to investigate the effect of shape (aspect ratio) and C-rate (current density) on the intercalation performance and the associated electromechanical reliability (see Figure 1 B). Three-dimensional simulations demonstrate the effect of the topology on the surficial electrochemical heterogeneities and its impact on the long-term performance of the device (see Figures 1 C & D).

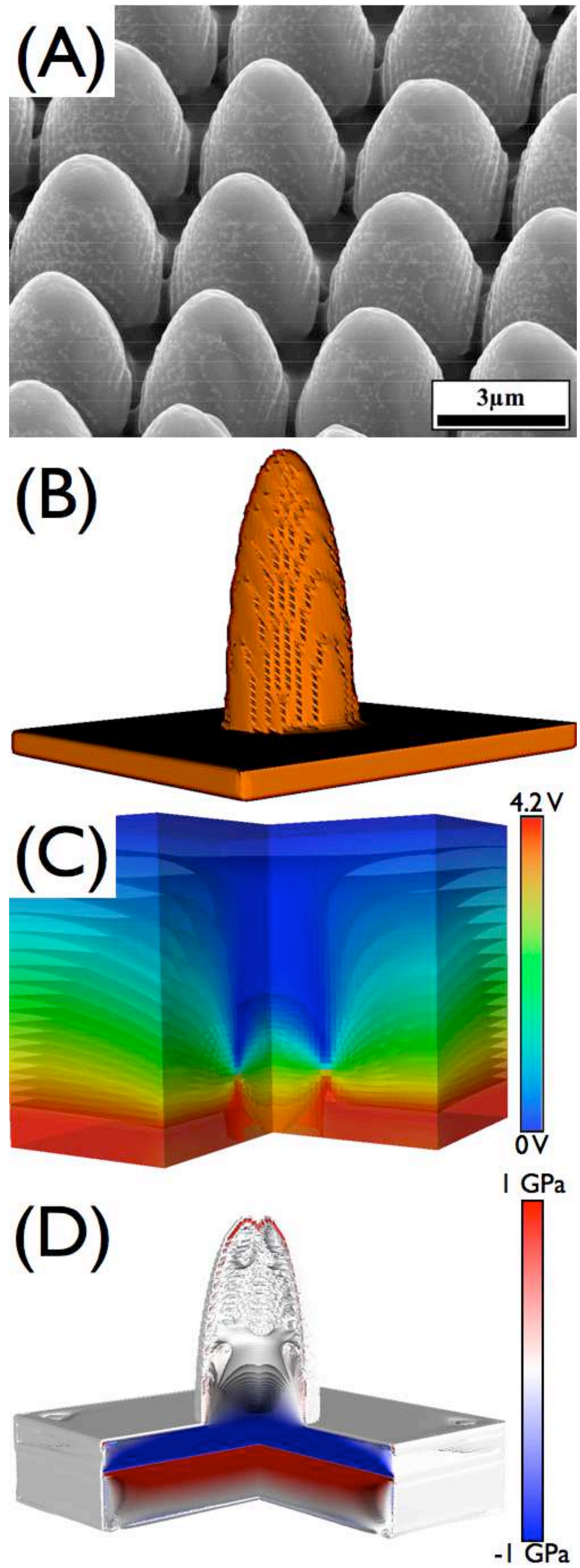

Figure 1: A) SEM micrograph of a three-dimensional laser structured battery electrode [1]. B) Simulation setup of the conical structure that is being used to analyze the intercalation rate, voltage field, and stress field.
C) 3D sectional view for the voltage field of the same microstructure toward the end of discharge.
D) 3D sectional view for stress field of the microstructure with a back contact layer appended to the bottom of the cathode.

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[1] R. Kohler, J. Proell, S. Ulrick, M.Przybylski, W. Pfleging, "*Laser processing of SnO2 electrode materials for manufacturing of 3D micro-batteries",* **SPIE** (7921), 1-11, 2011.