High throughput femtosecond laser processing for new generation battery

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ABSTRACT

Use of Ultra-Short Pulse lasers (UPLs) represent an advantageous technological choice on one hand to texture electrode collectors (CC, both Cu and Al) and on the other hand to structure the electrode active layer (EAL) of both anode and cathode. Whilst the first could enhance the electro-mechanical bonding of the EAL coated on CCs the second enables a faster battery recharging and the increase of electrode capacity.

We present the results obtained from extending the aforementioned processes to Gen 3b batteries, utilizing water-based material formulations to eliminate NMP and other toxic solvents. Three different kind of surface structures (LIPSS, micro-Grooves and DLIP) have been generated over CC and characterised via SEM and electrochemically, showing an improvement of the anode performances by 15%. Interestingly, Post-mortem analysis shows the possibility to prevent delamination phenomena observed on pristine CC after repeated cycling. High throughput processing is reported by using a 300 Watt UPL.

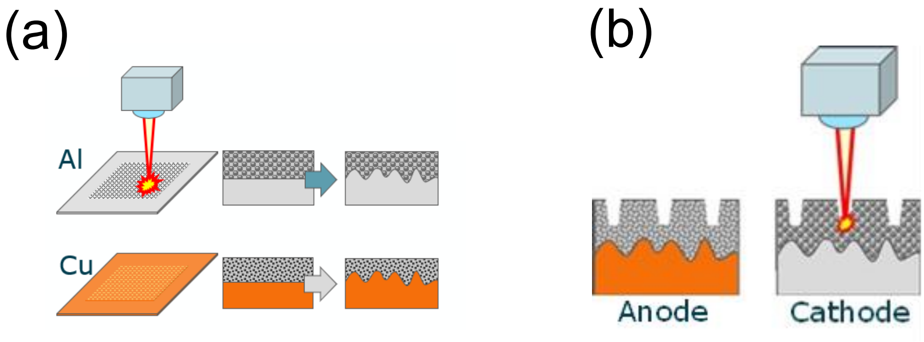
Also reported results obtained on structuring of EAL by means of micrometric holes. A 100 W femtosecond laser with POD capabilities has been used. The beam has been split in a matrix of identical sub-beams by a DOE, a fast galvo-scanner (20 m/s) has been utilised to increase the throughput and a surface as large as 10cm×10cm has been processed. Finally, a comprehensive morphological (SEM) and electrochemical characterisation of laser structured electrodes are reported.

We believe our results demonstrate that UPL represent an effective fabrication tool for enhancing the performance of next-generation battery technologies.

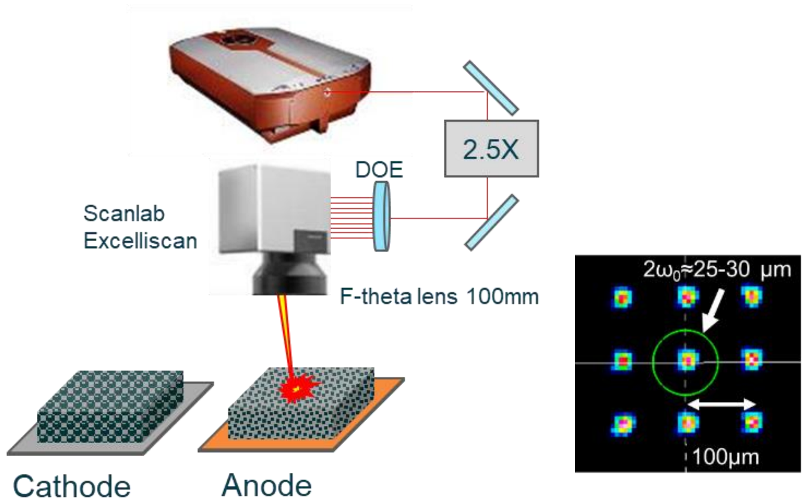
Keywords: USP laser machining, laser texturing, laser structuring, high power laser, battery fabrication, new generation battery

1. INTRODUCTION

2. EXPERIMENTAL



We carried out two different types of tests



3. RESULTS AND DISCUSSIONS

3.1 Texturing of charge collectors

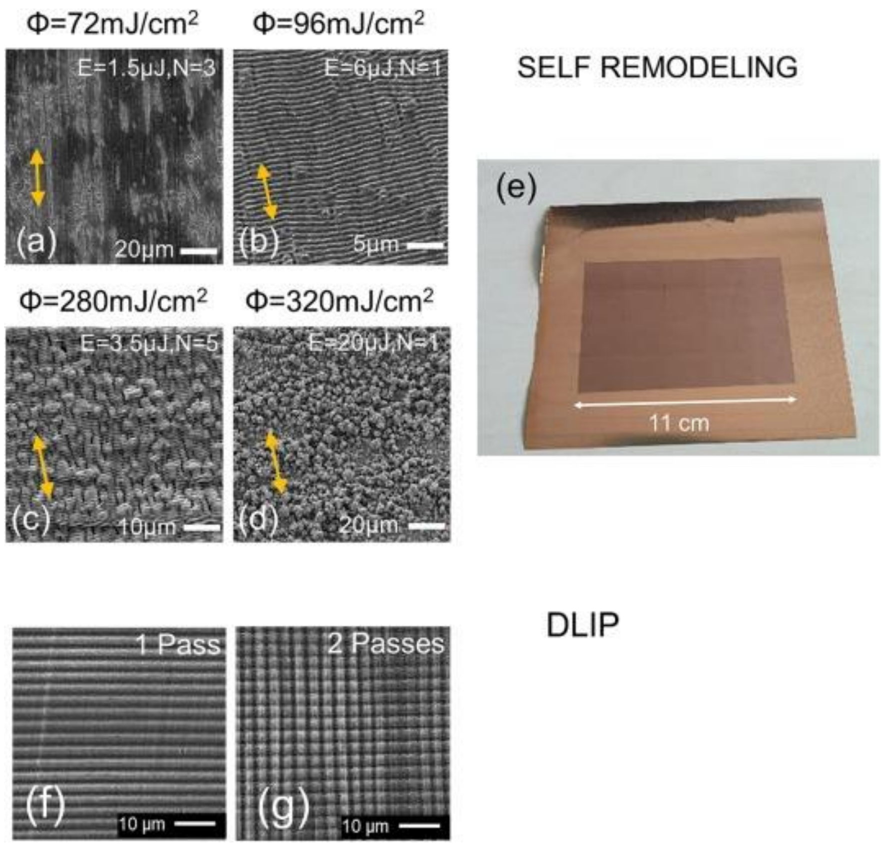
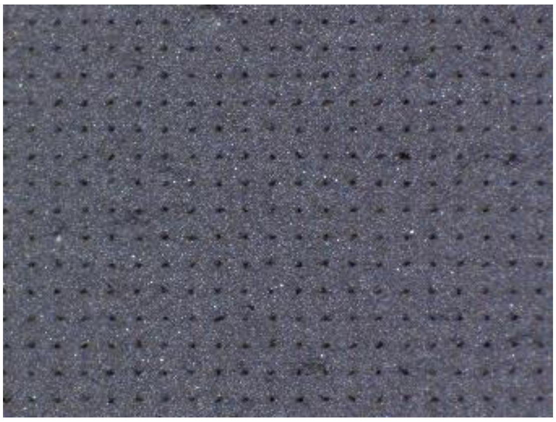
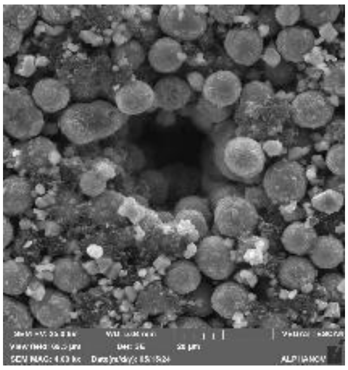


Figure 1SEM micrographs of laser textured CCs from the first batch (self-remodeling) (a)-(d), photograph of textured CC with μ-grooves (e), SEM micrographs of laser textured CCs from the second batch (DLIP) (f)-(g)

3.2 Texturing of the active layers





4. CONCLUSIONS

5. REFERENCES