Electronic Supplementary Material (ESI) for ChemComm.

Supporting Information: Enhancing the Performance of Germanium Nanowire Anodes for Li-ion Batteries by Direct Growth on Textured Copper

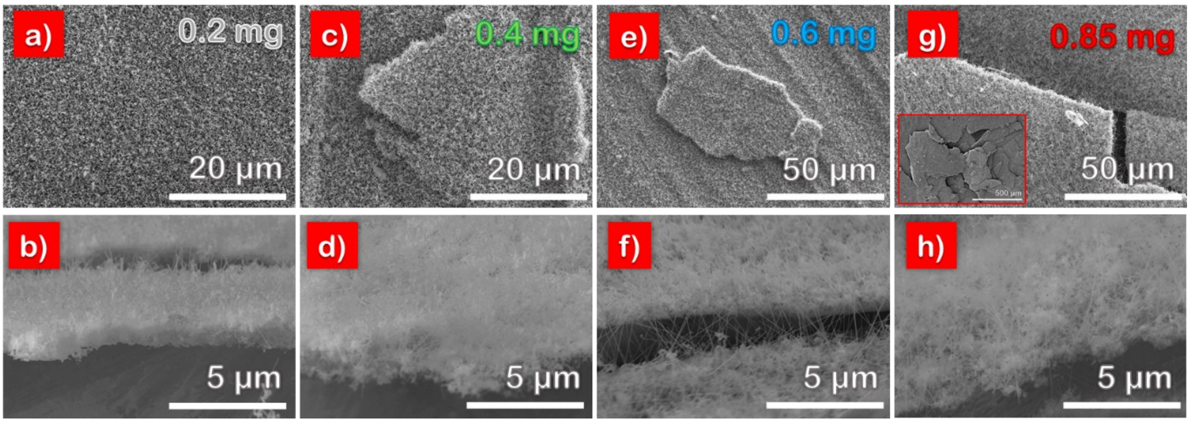

Figure S1: SEM images of Ge NW anodes from planar steel at different mass loadings, a,b) 0.2 mg/cm^2, c,d) 0.4 mg/cm^2, e,f) 0.6 mg/cm^2 and g,h) 0.85mg/cm^2

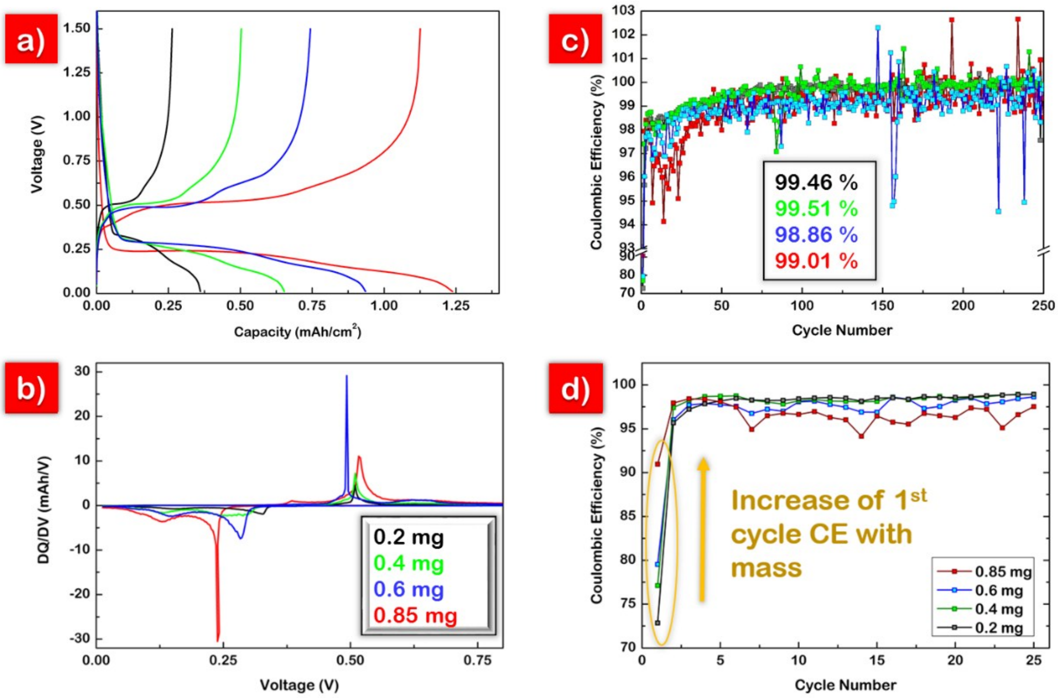

Figure S2: a) Voltage profiles for initial charge and discharge and b) corresponding DQ/DV plots, c) coulombic efficiency plot for 250 cycles showing (with inset average values) and d) zoomed in plot of first 25 cycles.

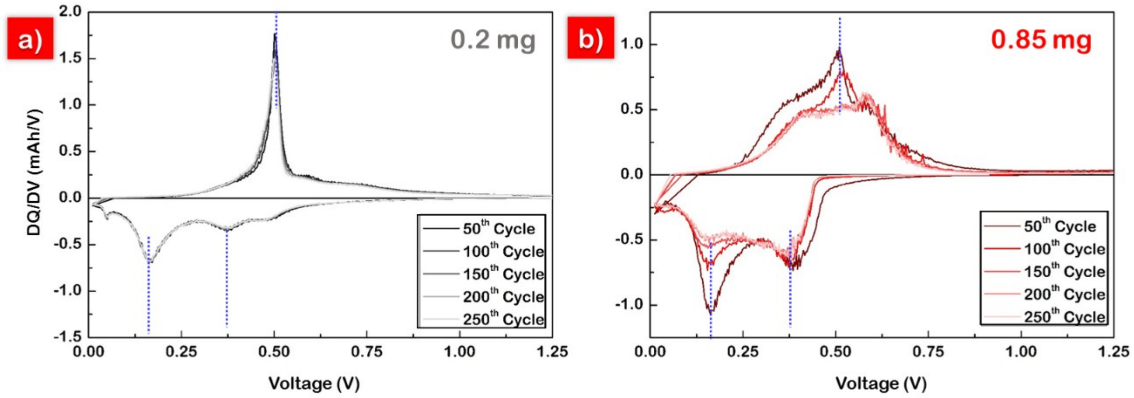

Figure S3: Differential capacity plots of SS based Ge anodes for a) 0.2 mg/cm^2 and b) 0.85 mg/cm^2 loading.

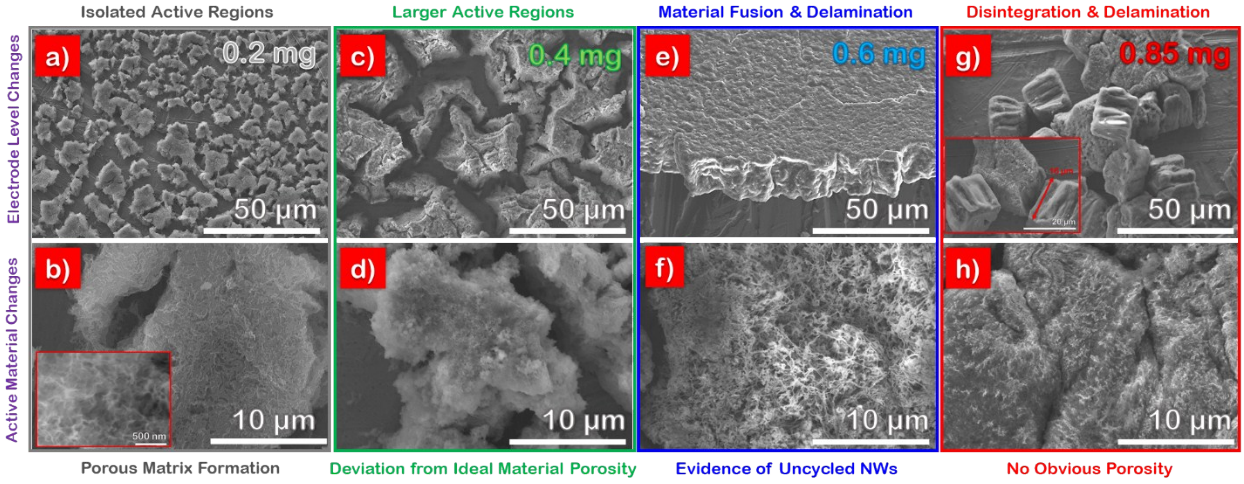

Figure S4: SEM images of post cycling anodes with mass loading between 0.2-0.85 mg/cm^2 showing the electrode level and active material level changes.

Post-mortem SEM analysis of the anodes after 250 charge/discharge cycles (after chemical removal of the SEI layer) showed interesting morphological effects. The 0.2 mg anode showed the formation of well adhered porous domains of Ge (typically of the order of 10 µm in size, Figure S4 a), that are consistent with the nanoscale ligament matrix previously reported (Figure S4 b).[13] At 0.4 mg loading, larger Ge domains up to 50 µm in size are observed (Figure S4 c), with a concurrent change from the continuous porous matrix to a rougher active material network (Figure S4 d). Increasing the mass loading to 0.6 mg led to the formation of much larger interconnected regions of Ge in excess of 100 µm (due likely to electrochemical assisted welding[38]), (Figure S4 e) and also the presence in certain areas of uncycled Ge NWs on top of the active material (Figure S 4f). It was also noted that the anode had experienced far more macro-scale material delamination, with less active material remaining adhered to the substrate prior to removal of the SEI layer. Further increase of the NW loading to 0.85 mg led to a more dramatic restructuring after cycling. The active material was found in the form of large chunks of Ge (up to 16 µm thick, Figure S4g)) which were clearly detached from the current collector in most cases. High magnification examination showed a rough texture of the active material

(Figure S4 h), likely due to pulverisation caused by the inavailability of void space required to successfully transform into the ideal stable porous network.

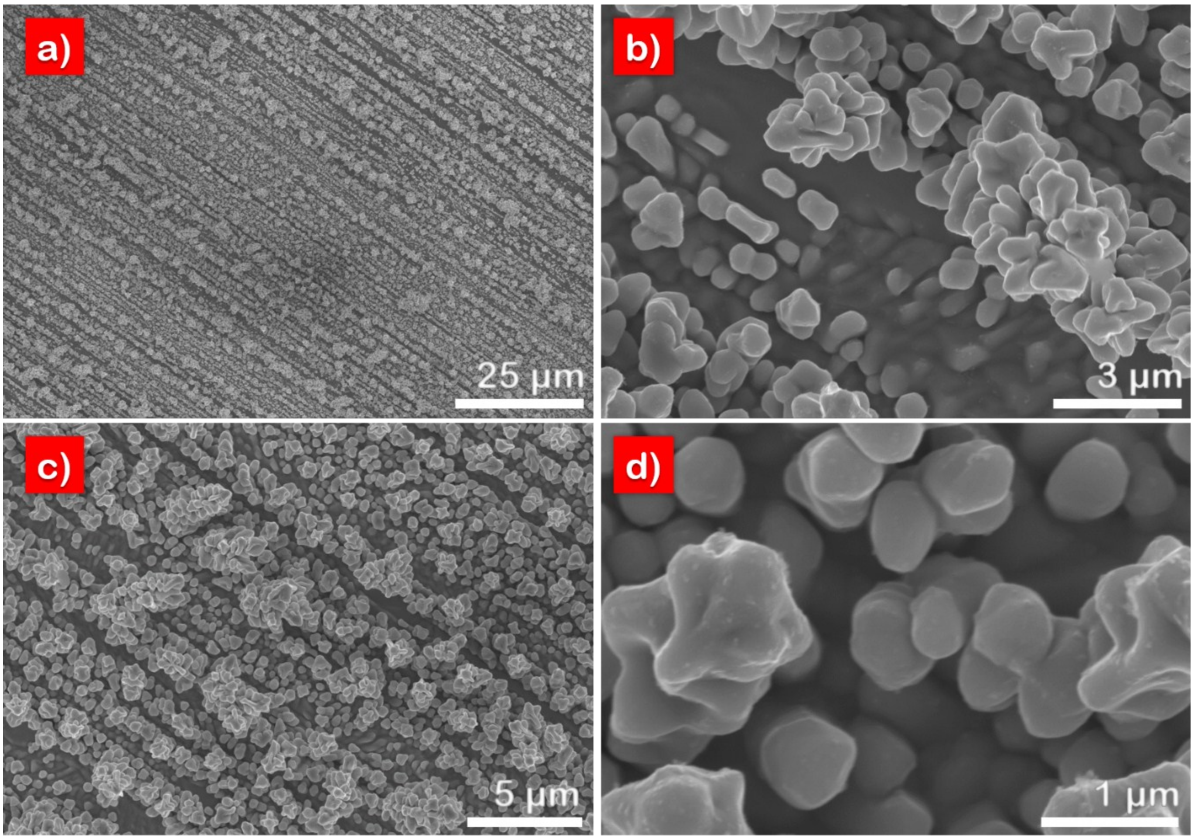

Figure S5: SEM images of pristine textured Cu foil used as current collector substrate.

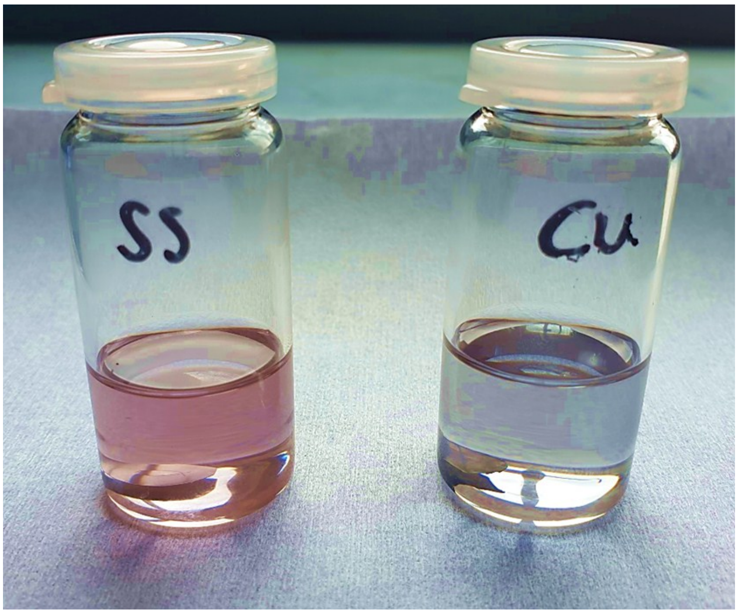

Figure S6: Photograph of SS and Cu based anodes with 1 mg/cm^2 coating after one hour sonication. The pink colouration of the SS solution is indicative of the removal of Ge NW from the substrate. The Cu solution remained colourless, showing the greatly enhanced adhesion of the active material.

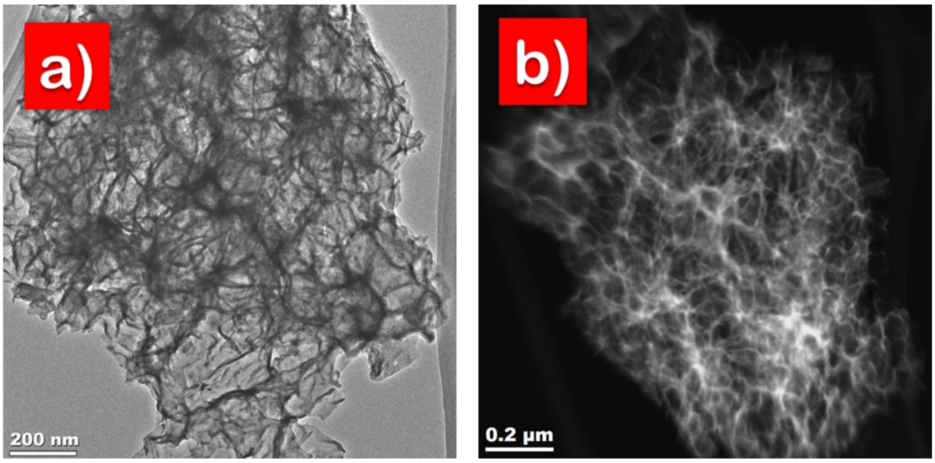

Figure S7: a) TEM and b) STEM image of porous active material formed on 1 mg/cm^2 Cu textured anode.