Internal resistance

a fundamental problem in carbon-microelectronics

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Internal resistance: a fundamental problem in carbon-microelectronics

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Carbon is an exciting material for electrochemistry due to the low cost, chemical inertness and wide potential window. Furthermore, microelectrodes and interdigitated electrodes with micro- and nanoscale gaps enable studies of rapid electron transfer kinetics [1] and redox cycling phenomena [2], which are not possible with macroscale electrodes. Therefore, the ability to fabricate carbon microelectrodes with well-defined architectures is highly interesting. Fabricating these carbon microelectrodes has become a lot easier with the introduction of laser-pyrolysis. The field has spawned a lot of papers in recent years, demonstrating high resolution down to 2 µm line width [3], applicability to a variety of precursors [4] and applications within biosensing [5] and energy storage [6]. However, the high-resolution electrodes suffer from high resistances and the application oriented electrodes have to compromise on size, essentially settling for macroelectrodes. Various tricks have been employed to overcome the conductivity issue such as sintering metal particles [7], but the purely carbon based electrodes are limited to conductivities on the order of 0.1-100 S/cm [8,9], much lower than metals. For the past year, we tried understanding, describing, and overcoming the challenge of internal resistance in laser-written carbon electrodes through a design approach to properly utilize the microscale dimensions. The work is still very much ongoing.

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