# *Geobacter sulfurreducens* Attachment and Biofilm Growth on Electrode Materials

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Many microbial communities form biofilms, and in special cases form electroactive biofilms (EABFs)[1]. Metal-reducing bacteria such as *Geobacter sulfurreducens* strain PCA are capable of forming such biofilms, and are commonly used in bio-electrochemical systems (BES). Previous work has used thin films (40 – 100 nm) of gold electrodes to perform electrochemical measurements of mature *Geobacter* biofilms[3, 4]. To better understand the interactions and compatibility between *Geobacter* and electrode surfaces, we characterize *Geobacter sulfurreducens* growth and biofilm formation on thin-film materials.

A Dual Gun Electron Beam Evaporation Chamber (E-beam) was used to deposit thin films of gold (Au), iron (Fe), and silver (Ag) onto glass coverslips. The thickness and deposition rates were intentionally varied across samples, and titanium was used as an adhesive metal. Carbon (C) nanospikes were also used as an additional surface treatment for comparison with metal thin films. Nanospikes were grown on a quartz cover slide via a non-catalytic, plasma enhanced chemical vapor deposition (CVD) process. This method may be advantageous for electrode applications as the carbon nanospikes have a high degree of surface area in comparison to traditional thin film deposition methods using an E-beam or pulsed, direct current (DC), sputtering. Methods for initiating *Geobacter* biofilm formation were developed using glass coverslips, and subsequently used throughout these studies to evaluate microbial attachment, growth and biofilm formation on thin film electrode materials to identify any material preferences stemming from thin-film composition or topography.

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2. Malvankar, N.S., et al., *Tunable metallic-like conductivity in microbial nanowire networks.* Nat Nano, 2011. **6**(9): p. 573-579.
3. Snider, R.M., et al., *Long-range electron transport in Geobacter sulfurreducens biofilms is redox gradient-driven.* Proceedings of the National Academy of Sciences of the United States of America, 2012. **109**(38): p. 15467-15472.

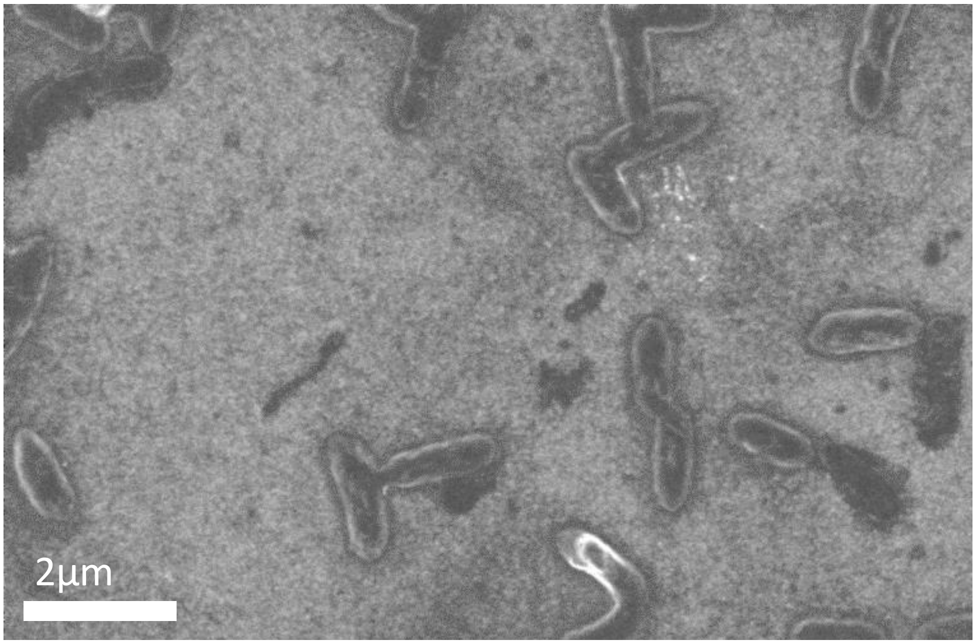


*Figure 1: A scanning electron microscope image of Geobacter sulfurreducens on carbon nanospike surface, coated with 100 nm of chromium. The carbon nanospikes were deposited on quartz through a non-catalytic, plasma enhanced chemical vapor deposition (CVD) process.*

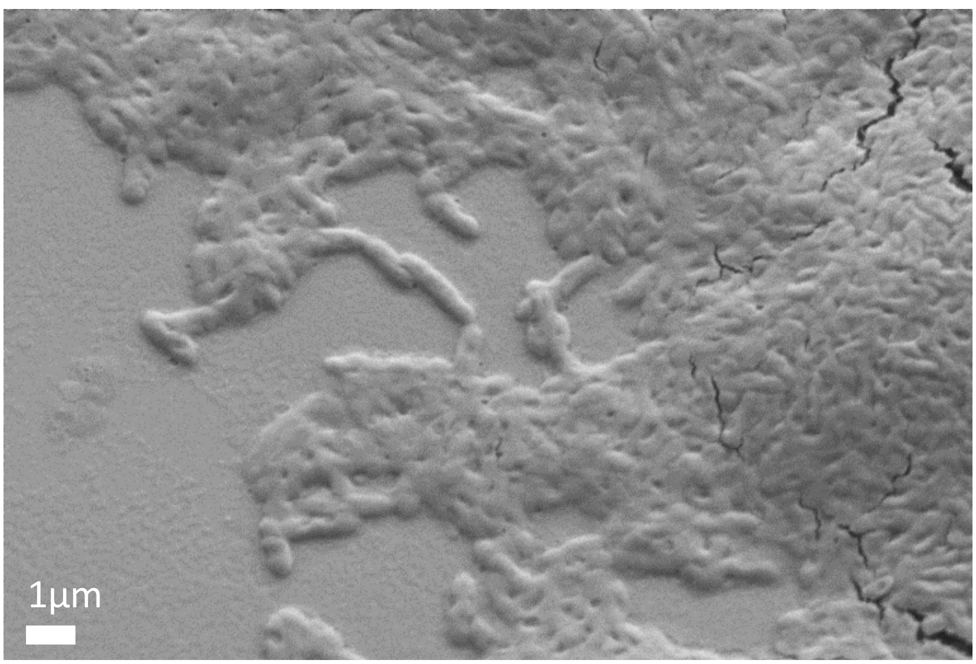


*Figure 2: A scanning electron microscope image of Geobacter sulfurreducens on a glass coverslip. The biofilm was coated with 100 nm of chromium before imaging. Preparation methods: 0.1 mL of Geobacter sulfurreducens in DCB-1 medium with fumarate and acetate, Optical Density of 0.06 at 600 nm was pipetted onto glass and let sit for 120 minutes. The coverslip was tilted in order to discard medium and unattached Geobacter, and then placed in 3 mL of DCB-1 medium with fumarate and acetate. At the end of 3 days, the coverslip was removed from the medium, and imaged with an Olympus, brightfield microscope.*