



**CALIFORNIA STATE SCIENCE FAIR
2009 PROJECT SUMMARY**

Name(s) Daniel Gay	Project Number J0516
Project Title Effects of Voltage and Concentration on the Fractal Dimension of Electrodeposited Copper Aggregates	
<p style="text-align: center;">Abstract</p> <p>Objectives/Goals For this project, I set out to determine the effects of voltage and concentration of copper sulfate solutions on the fractal dimension of copper aggregates created through a form of electrodeposition called diffusion-limited aggregation. A fractal is anything that is self-similar, meaning the only structural differential between an object and its components is scale. Fractal dimension is a measure of the complexity or self-similarity of an object.</p> <p>Methods/Materials The way that I formed copper aggregates for this experiment was through a process called electrodeposition; a process that uses a weak electric field and Brownian motion to form aggregates from a copper sulfate solution. By using copper wires as electrodes on the rim and center of a Petri dish, an electromagnetic field was created. That field pushed the copper ions in the solution towards the center electrode. This field, combined with Brownian motion, (the random walk a particle takes when it is suspended in a liquid,) creates the fractal through a mechanism called diffusion-limited aggregation.</p> <p>Results For this project, I used three voltages: 5V, 12V, and 19V. I also used two copper sulfate concentrations: 0.1 Molar and 1.0 Molar. The copper aggregates were then photographed and analyzed with FracLac for ImageJ software from the National Institute of Health. All of the formed copper aggregates had fractal dimensions between 1.5 and 1.9.</p> <p>Conclusions/Discussion My hypothesis on the effect of copper sulfate concentration was not supported; contrary to my expectations the 0.1M tests had higher fractal dimensions than the 1.0M trials. For my hypothesis regarding the effects of voltage, it was partially supported. In the 1.0M tests greater voltage translated to greater fractal dimension. However, in the 0.1M trials, the hypothesis was not supported.</p>	
Summary Statement The purpose of this experiment was to determine what impacts voltage and concentration have on the formation of electrodeposited copper aggregates which are created through diffusion-limited aggregation.	
Help Received Father helped me to acquire project materials and set-up experiment. Mother helped paste components on presentation board. Mrs. Miller, a science teacher at my school, explained complex concepts involving the calculation of fractal dimension.	