SWNT Based Air Cathodes for Fuel Cells & Metal Air Batteries
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The goal of this project is to develop and use novel gas diffusion oxygen reducing electrode (air cathode) based on single wall carbon nanotube (SWNT) films in zinc-air batteries and fuel cells. Metal-air batteries, utilizing surrounding air as an inexhaustible cathode material have the highest specific and volumetric energy density of any primary battery system available. Gas diffusion oxygen electrodes, where molecular oxygen is electrocatalytically reduced, are vital to battery and fuel cell performance. The air cathode should be permeable to air or another source of oxygen, but must be substantially hydrophobic so that electrolyte will not leak though it, and have an electrically conductive element connected to external circuitry. Generally, conventional air cathode is a thick multilayer film comprising carbonaceous powder mixed with nanoscale metal catalyst to promote oxygen reduction and hydrophobic polymer additive pressed onto electrically conductive layer. While noble metals such as platinum that are commonly used as catalysts in conventional air cathodes offer the advantages of intrinsic catalytic activity, their deficiency in resource, high costs, and susceptibility to catalyst poisoning, have become a serious concern for commercial applications. An optimized SWNT based air cathode catalyst that would constitute a significant improvement in existing technologies is being developed. This new system avoids precious metals, is not poisoned, is thin, light-weight, and resists electrolyte flooding.

Findings to date indicate that the catalyst being developed is competitive with platinum in terms of its oxygen reduction activity in alkaline and neutral pH environments. This makes it suitable for a broad range of power generating devices including alkaline fuel cells, enzyme based biofuel cells, microbial fuel cells, micro-fuel cells, small direct methanol fuel cells and advanced metal-air batteries.

Our findings will contribute to making fuel cells economically viable and permit broader implementation of long lived sources of portable power. Platinum is costly because of its actual scarcity on Earth versus its importance and utility in many chemical processes. It has been estimated that if the worlds fleet of 500 million internal combustion vehicles were converted to fuel cell power plants using platinum catalysts (what is used in today's fuel cells) the world's supply of platinum would be exhausted in only 15 years (even with recycling). This is perhaps the biggest roadblock to a viable hydrogen economy.

Our work involves single wall carbon nanotubes which are themselves costly in today's market. The difference compared to platinium however is that this is not due to any scarcity of carbon from which nanotubes are made but rather because the motivation for their bulk manufacture (and attendant economy of scale) has been lacking. Our finding may change that equation.

Since patent is pending on this work, detailed report will not be provided.

Examples of applications: Metal-air batteries and fuel cells generate clean, reliable energy for transportation, stationary and portable applications such as:


Low/zero-emission vehicles, spacecraft etc.


Portable electronics

Residential/business back-up power generators