BIO-CELL: A Novel MicroCHP pMMO Enzymatic Biofuel Cell for the Generation of Clean and Reliable Electrical Energy

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Hydrogen-powered fuel cells have the potential to generate clean and efficient electricity while minimizing dependence on fossil fuels and protecting the environment. Current manufacturing processes for hydrogen, however, are costly, produce harmful chemicals and require intensive electrical and thermal energy. Methane, as a fuel source for electricity generation, is a more practical alternative as it is abundant and does not need to be manufactured. Solid oxide fuel cells (SOFCs) use methane and other hydrocarbons to generate electricity, however, they are expensive, possess long start-up times, release harmful greenhouse gases and operate at very high temperatures (500-1000 degrees Celsius). Enzymatic biofuel cells have the potential to overcome these barriers. BIO-CELL is the first to propose the creation of a combined heat and power, particulate methane monooxygenase (pMMO) enzymatic biofuel cell for large scale electricity generation. Via gas chromatography, methane oxidation rates from methanotrophic bacterial cultures were deduced over a period of time with results indicating MMO enzyme efficiency at room temperature. Furthermore, computational designing of BIO-CELL and subsequent bioelectrochemical analysis indicated an electromotive force of 0.88V and an ideal system efficiency of 80-85%. As a scalable, flexible, energy-efficient, and power-independent device, BIO-CELL is capable of directly converting methane (a harmful greenhouse gas) into liquid methanol (an alternative energy source) at room temperature while generating clean, reliable and affordable electricity (with no input thermal energy and no air pollution or carbon dioxide emissions) to power buildings, vehicles, factories, homes, and communities worldwide.

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