Nanominiaturization of a Hydrogen Plant

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In recent years, there has been considerable interest in developing miniature subwatt electric power generation using hydrocarbon fuels. The objective of our research was to develop a power supply with an energy density greater than currently available secondary (rechargeable) batteries for microelectronic devices such as micro-electro-mechanical systems (MEMS) and microsensors. Because of the high energy density of hydrocarbons (e.g., methanol at ~5.6 kWh/kg compared with lithium-ion batteries at ~0.12 kWh/kg), even a very inefficient chemical to electrical energy conversion device could be a significant improvement over currently available secondary battery technology. The presentation will describe development of a subwatt microscale methanol processor that reproduces the unit operations of a large-scale hydrogen plant, only at a scale one billion times smaller. The microscale processor system consists of two vaporizers, a heat exchanger, a catalytic combustor, a methanol reformer, and a carbon monoxide cleanup reactor. The total volume of the processor system is less than 0.2 cm^3 and weighs less than 1 gram. The methanol reformer reactor is less than 5 mm^3. The processor can be operated without any external heating.