Autothermal Catalytic Micromembrane Devices for Portable High-Purity Hydrogen Generation

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The high efficiency and energy density of miniaturized fuel cells provide an attractive alternative to batteries in the portable power generation market for consumer and military electronic devices [1-3]. The best fuel cell efficiency is typically achieved with hydrogen, but safety and reliability issues remain with current storage options. Consequently, there is continued interest in reforming liquid fuels to hydrogen. The process typically involves high temperature reforming of fuel to hydrogen combined with a low temperature PEM fuel cell, which implies significant thermal loss. Owing to its high hydrogen content (66%) and ease of storage and handling, methanol is an attractive fuel. However, partial oxidation of methanol also generates some CO, which may poison the fuel cell catalyst.

Previously [4] we successfully demonstrated hydrogen purification using thin (~200 nm) Pd-Ag membranes using electrical heating. Further, integration of these devices with \( \text{LaNiCoO}_3 \) catalyst allowed methanol reforming at 475°C with 47% fuel conversion [5]. Since microreactors possess high surface area to volume ratio, minimizing heat loss is important. Hydrogen flux across the Pd membranes is an equilibrium controlled process. Thus to achieve thermal management, the unextracted hydrogen, generated CO, and unreacted methanol can be completely oxidized in a separate reactor.

In the current work, we explore the realization of autothermal hydrogen generation by fabricating silicon-based reactors using bulk micromachining techniques. The hydrogen generation unit comprises a 200-nm palladium-silver membrane coated with a reformer catalyst while the combustor is loaded with platinum catalyst. High thermal conductivity of silicon ensures autothermal operation. Upon thermal isolation using vacuum packaging [6], we characterize the performance of this integrated, autothermal hydrogen generation system in terms of energy efficiency and hydrogen production.

**REFERENCES**


