Catalytic Micromembrane Devices for Portable High-Purity Hydrogen Generation

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The development of portable-power systems employing hydrogen-driven fuel cells continues to garner significant interest in the scientific community, with applications ranging from the automotive industry to personal electronics. While progress has been made in the development of efficient hydrogen-storage devices, it is still preferable for portable-power systems to operate from a liquid fuel with a high energy density (e.g., methanol, ammonia). This necessitates the integration of a hydrogen generator capable of converting stored fuels to hydrogen to drive the fuel cell.

Previous research has focused upon the development of novel catalysts and autothermal microreactor designs for efficient conversion of liquid fuels (e.g. methanol, ammonia) into hydrogen for use by a polymer-electrolyte fuel cell [1]. Additionally, micromembrane devices (Figure 1) have been developed for purification of the resulting hydrogen stream to remove impurities (e.g. CO) that adversely affect fuel cell performance [2]. Our current research aims to integrate (i) catalyst design, (ii) autothermal microreformer design, and (iii) micromembrane technology to realize microscale chemical systems capable of producing high-purity hydrogen for fuel cell operation. By combining microfabrication techniques for generation of micromembrane devices with wet-chemical deposition methods for a variety of catalysts, multiple membrane reactor applications for hydrogen generation can be realized, taking full advantage of superior mass transport and film permeabilities achievable at the microscale. Results obtained for LaNi$_{0.95}$Co$_{0.05}$O$_3$ perovskite catalysts integrated with 23 wt% Ag-Pd membranes (Figure 2) demonstrate promising high-purity hydrogen yields at low methanol feed compositions, and demonstrate the applicability of catalytic membrane reactors effected at the microscale for efficient production of high-purity hydrogen. Resulting microdevices are directly applicable as part of an integrated portable-power system.

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