A MEMS Steam Generator

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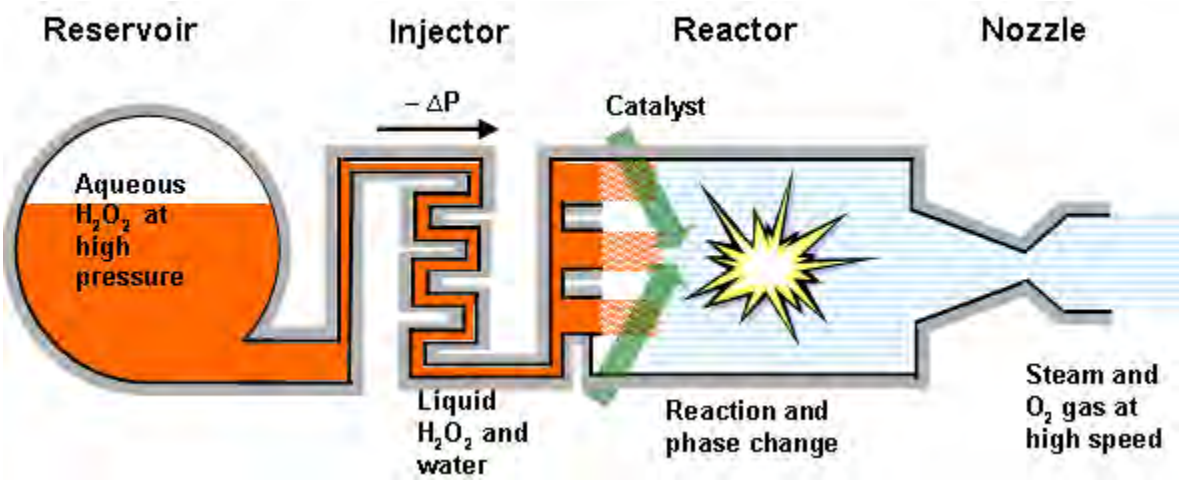
Previous work [1] has shown that MEMS technology has significant potential to create more compact, higher- performing hardware for chemical oxygen iodine lasers (COIL). In COILs, the laser medium is a flowing gas that must be pumped through the system at high mass flow rates to ensure proper system operation. As a result, compact pumps with high pumping rates are a key element of the COIL system. One promising component of a MEMS COIL system would be a compact MEMS pump system in which the pump action is provided in part by micro steam ejectors and the micro steam generators that supply their driving fluid. This work describes the design and modeling of a microscale hydrogen peroxide (H_2O_2)-based steam generator to supply such a MEMS pump system. Hydrogen peroxide is a readily available, inexpensive, nontoxic, and environmentally friendly fluid that may be catalytically decomposed to form steam. Steam generation by the catalytic decomposition of H_2O_2 also finds other important applications in the MEMS field beyond pumping, particularly in the area of thrust generation. Compared to their macroscale counterparts, MEMS H_2O_2-based steam generators offer better performance, notably improved mixing, and higher uniformity due to the absence of moving parts [2-3].

A complete MEMS steam generator consists of a peroxide reservoir, an injector, a reactor, and a converging-diverging nozzle to accelerate the exiting flow, as shown in Figure 1. Initial work focuses on the design of the reactor and nozzle. Liquid H_2O_2 in aqueous solution is injected into the reactor, where it decomposes into steam and oxygen gas upon contact with the catalyst. A continuous supply of homogeneous liquid catalyst is used, as it avoids the aging problem typically exhibited by heterogeneous catalysts [4]. The gaseous products of the reaction are then accelerated to supersonic velocities through the converging-diverging nozzle. The work to date indicates that a MEMS steam generator designed to minimize heat transfer to the environment can provide complete, compact, uniform decomposition of peroxide into steam suitable to drive a MEMS pumping system.



▲ Figure 1: Schematic diagram of a hydrogen peroxide-based MEMS steam generator, showing the peroxide reservoir, injector, reactor, and nozzle.

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