**Integrated Miniature Catalytic Combustor for Fuel Processor Applications**

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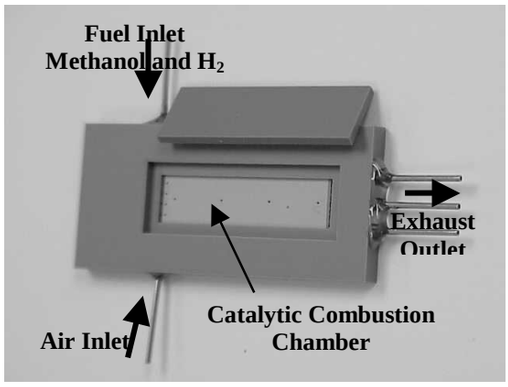
A miniature methanol steam reformer is being developed to generate on-board hydrogen gas to run small fuel cells for portable power applications. Steam reforming is an endothermic reaction and heat must be supplied to sustain the reaction. Development of an efficient and compact combustor is needed to provide and regulate the heat required for carrying out the steam reforming reaction. This paper describes the design and development of a miniature catalytic combustor that can be integrated with a miniature methanol steam reformer for portable fuel cell applications in the range of 1 - 20W. The catalytic combustor was designed to fit the footprint (35mm x 15mm x 5mm) of a miniature steam reformer, and fabricated using multi-layer ceramic technology. The multi-layer technology enables a 3D integration of the catalytic combustor with the miniature steam-reforming reactor. Fig. 1 shows a cut-away view of one of the ceramic catalytic combustor designs tested in these experiments.

Fig. 1 Cut-away view of a multilayer ceramic catalytic combustor test vehicle with a single large cavity as the combustion chamber.




In fuel cell applications, this catalytic combustor should be able to oxidize $H_2$, CO and methanol vapor in the presence of air. Platinum catalyst was used in these combustion experiments. Issues with the methods of catalyst deposition, interaction of the catalyst with the ceramic substrate used in the fabrication, and the stability of the catalyst during the combustion process will be discussed. Fig. 2 shows a typical heating profile along the length of the combustor obtained by combusting $H_2$ using stochiometric air/fuel mixture. For steam reformer applications, the control of temperature gradients over the reforming catalyst bed and the fuel vaporizer is very important. Combustor designs with six micro channels (100um x 250um cross-section, 0.8" length) coated with catalyst in place of the single large combustion cavity shown in Fig. 1 were evaluated. Temperature gradients obtained within the ceramic reactor by combusting methanol vapor and hydrogen with air under various stochiometric ratios were evaluated. Start up issues and various factors influencing the design of the combustor for the overall efficiency of an integrated steam reformer with a high temperature polymer membrane fuel cell system will be discussed.

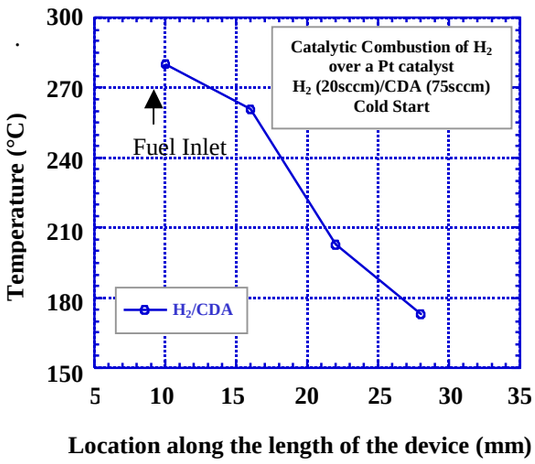



Fig.2 Temperature profile along the length of the combustor test vehicle shown in Fig1. Hydrogen and methanol combustion in air over a Pt catalyst