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Author: Dr. Robert-Jan Koopmans
Austria

Mr. Varun Nandyala
FOTEC Forschungs- und Technologietransfer GmbH, Austria
Ms. Sara Pavesi
FOTEC Forschungs- und Technologietransfer GmbH, Austria
Dr. Yann Batonneau
France
Mr. Corentin Maleix
CNRS, France
Dr. Romain Beauchet
Université de Poitiers, France
Dr. Martin Schwentenwein
Austria
Mr. Manfred Spitzbart
Austria
Mr. Altan Alpay Altun
Austria
Dr. Carsten Scharlemann
University of Applied Science Wiener Neustadt, Austria

COMPARISON OF HTP CATALYST PERFORMANCE FOR DIFFERENT INTERNAL MONOLITH STRUCTURES

Abstract

Monopropellant propulsion systems rely on the rapid decomposition of the propellant triggered by a catalyst. The net effect of the decomposition process is a significant rise in temperature of the products. Typical requirements for catalysts are that the decomposition reaction is fast, have a long lifetime and that the pressure drop over the catalyst is minimal. Catalysts of the particulate type (beads, spheres, pellets) are frequently used for inspace applications. These type of catalysts, however, have a number of disadvantages, such as the high pressure drop over the bed, the tendency of attrition due to abrasion and the existence of preferred flow path leading to channelling and subsequent non-decomposition of the propellant. An alternative to these catalysts are monoliths. Traditionally, they are produced by extrusion of a ceramic paste through a die, leading to monoliths with straight channels. Although it mitigates typical drawbacks of particulate type catalysts, other drawbacks are created such as a low maximum bed loading. This leads to bulky designs of thrusters with this type of catalysts. Fairly recently, a technique has become available to manufacture monoliths called lithography-based ceramic manufacturing (LCM). This is an additive manufacturing technique with which it is possible to manufacture complex three-dimensional ceramic structures. This enables the design of catalysts that combine the advantages of particulate and monolithic type catalysts, while not suffering from their respective disadvantages. To gain a better understanding of the possibilities such catalysts offer, a test campaign was conducted to gain insight into how the internal structure influences the performance of the catalysts. For this, four

monoliths with different internal structures were subjected to a flow of concentrated hydrogen peroxide. To ease the comparison between the results of the catalysts, the design was such that catalytic surface area to body volume ratio as well as the Reynolds number were similar. The former was in a previous study found to be an important indicator for the transient temperature performance. The latter ensures a similar level of turbulence and thus a similar level of transport of fresh hydrogen peroxide to the catalytic surface. It was furthermore ensured that the internal structure is small relative to the size of the catalyst. In this way the catalyst can be considered to be homogeneous from a flow point of view. The paper will present initial results of the hot firing tests performed with these catalysts.