ERBURIG^{H} Test Facility: The Next Step of Material Testing for H2/O2 Rocket Combustion Chambers

K. Bubenheim[1], C. Wilhelmi[1]
S. Beyer[2], S. Schmidt-Wimmer[2]

[1]EADS Innovation Works, Munich, 81663, Germany
[2]ASTRIUM Space Transportation, Munich, 81663, Germany

Material testing for rocket combustion chambers is a challenging task. The atmosphere of combustion of hydrogen and oxygen, as it is used in the European VULCAIN II rocket engine, tends to extremely degrade the combustion chamber liner during operation. This degradation is linked to the loss of the optimal oxygen-to-fuel-ratio for the combustion due to premature influx of hydrogen through cracks between the cooling channels and the combustion chamber. This leads to a loss in thrust and possibly to an unsuccessful mission.

For this reason there are various different kinds of testing methods and testing facilities to investigate the application limits of the liner material and prevent degradation. In general two different areas of testing are interesting: mechanical and thermal testing of the combustion chamber material. The present paper will be focusing on the thermal testing of copper-based combustion chamber material. The testing methods range from simple thermal testing in thermogravimetric analysis (TGA) furnaces to full-scale rocket engine tests in specialized testing centers. While full-scale rocket engine tests are extremely expensive, thermogravimetric analyses are less complex but neglect some important values like gas velocity and sample geometry.

One of the major degradation effects is “blanching” of the copper-based material. This effect creates a sponge-like surface which is thought to be caused by repeated oxidation and reduction of the material. While you can try to simulate the oxidation and reduction of the material using TGA furnaces to do initial material screening tests to compare to a certain standard, the “blanching” mechanism is not yet fully understood and described.

Using the Environmental Relevant Burner Rig - Hydrogen (ERBURIG^{H}) test facility of EADS Innovation Works in Ottobrunn it is planned to evaluate the liner material in a micro-scale combustion chamber to, in contrast to TGA set-ups, incorporate geometric effects and add a realistic gas flow velocity.