HIGH PERFORMANCE SPACE STRUCTURE SYSTEMS GMBH

Safety Improvement Thermal Protection for Re-entry Vehicles (SAFIT)

Re-entry vehicles are exposed to very high temperatures entering the earth's atmosphere. The vehicle is protected by TPS (*Thermal Protection System*), normally by an outer ceramic shingle layer and a high temperature insulation keeping away the heat from the aluminium structure (*cold structure*). But in case of anomalies in this protection like a local hole in nose cap ceramics or leading edges) the re-entry heat would damage the cold structure, up to a tragic complete loss of the spacecraft and its passengers.
A dedicated ablator or a ceramifiable polymer can provide a secondary protection layer for the cold structure. The protection will automatically be "activated", when a certain specified temperature will be overpassed. Then, it protects the cold structure against the heat for the rest of the re-entry phase. In case of a nominal flight the secondary protection keeps its original configuration and is therefore re-usable without maintenance.
As the additional mass of the secondary protection is marginal, one can speak about a "*Smart TPS*". It improves the reusable launch vehicle's safety and reduces the post-flight inspection cost.
This new concept is developed and tested (with heaters up to 1600°C and with plasma arc jets) in the frame of an ESA Technology Study since 2004 up to now. Presently the protection material will be improved and optimized.

Specification:

Material Type: Silicon resin filled with glass ecospheres	
Activation Temperature:	>200°C
Operational Temperature:	500 - 900°C
Maximum Temperatures:	1600°C
Location:	Leading Edge
Nominal thickness:	1 - 6 mm
Thickness after re-entry:	2 - 50 mm
Weight:	1 kg/m2
Lifetime:	20 re-entries

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Application

Enormous failure in a space shuttle leading edge (left: test after Space Shuttle Columbia desaster in 2003).
The target failures for SAFIT are holes with diameters between 1-50 mm and leakages between the ceramic shingles.

Feasibility Tests

Plasma Arc Jet test with whole TPS configuration

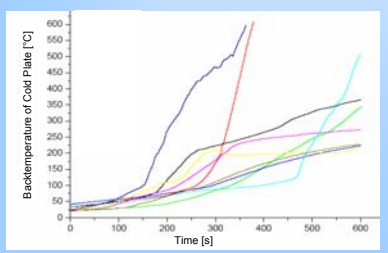
Heat Test with secondary protection up to 1600°C

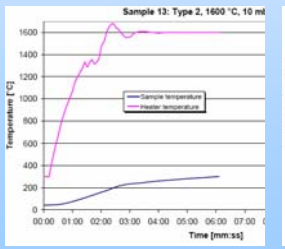
Protection before tests

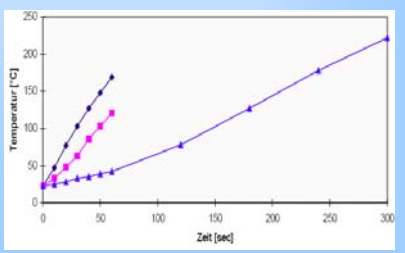
Insulation and protection after arc jet test

Protection after heat tests

Thermal Analysis







Many thermal analysis have been performed in order to dimension the protection and to correlate with tests