

Analysis of Differential Recession Between RTV 560 and PICA under High-Enthalpy Conditions



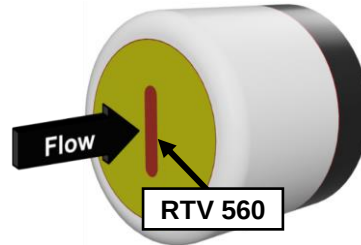
Joshua M. Migrditchian¹

¹Dougherty Valley High School

National Aeronautics and Space Administration

I. Introduction

RTV 560 is used as a gap filler between tiles of thermal protection systems (TPS) such as Phenolic Impregnated Carbon Ablators (PICA). Additionally, NuSil is a surface coating applied to the TPS prior to flight for clean room purposes. Samples of PICA were analyzed in the NASA Hypersonic Materials Environmental Test System (HyMETS) arc jet to simulate material response in environments relevant to Mars and Titan. The goal of this study was to analyze the fencing phenomenon resulting from differential recession between PICA, NuSil and RTV.



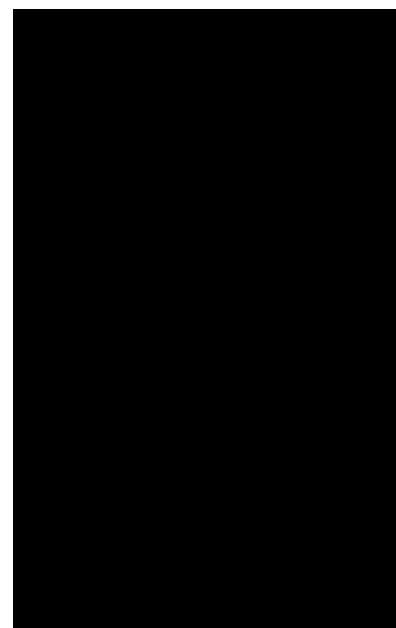
Test Sample Assembly

II. Test Matrix

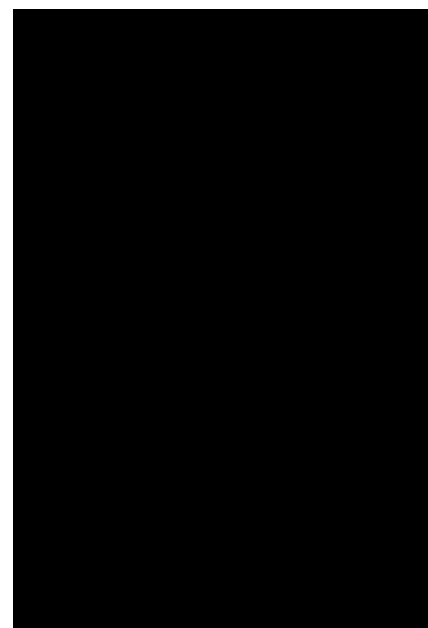
PICA-RTV-NuSil Test Conditions

Sample Name	Test Time (s)	Heat Flux ($\text{W}\cdot\text{cm}^{-2}$)	Stagnation Pressure (kPa)
CO ₂ -2	109.7	94.2	5.28
N ₂ -2	90.1	98.6	3.53

III. High Speed Videos

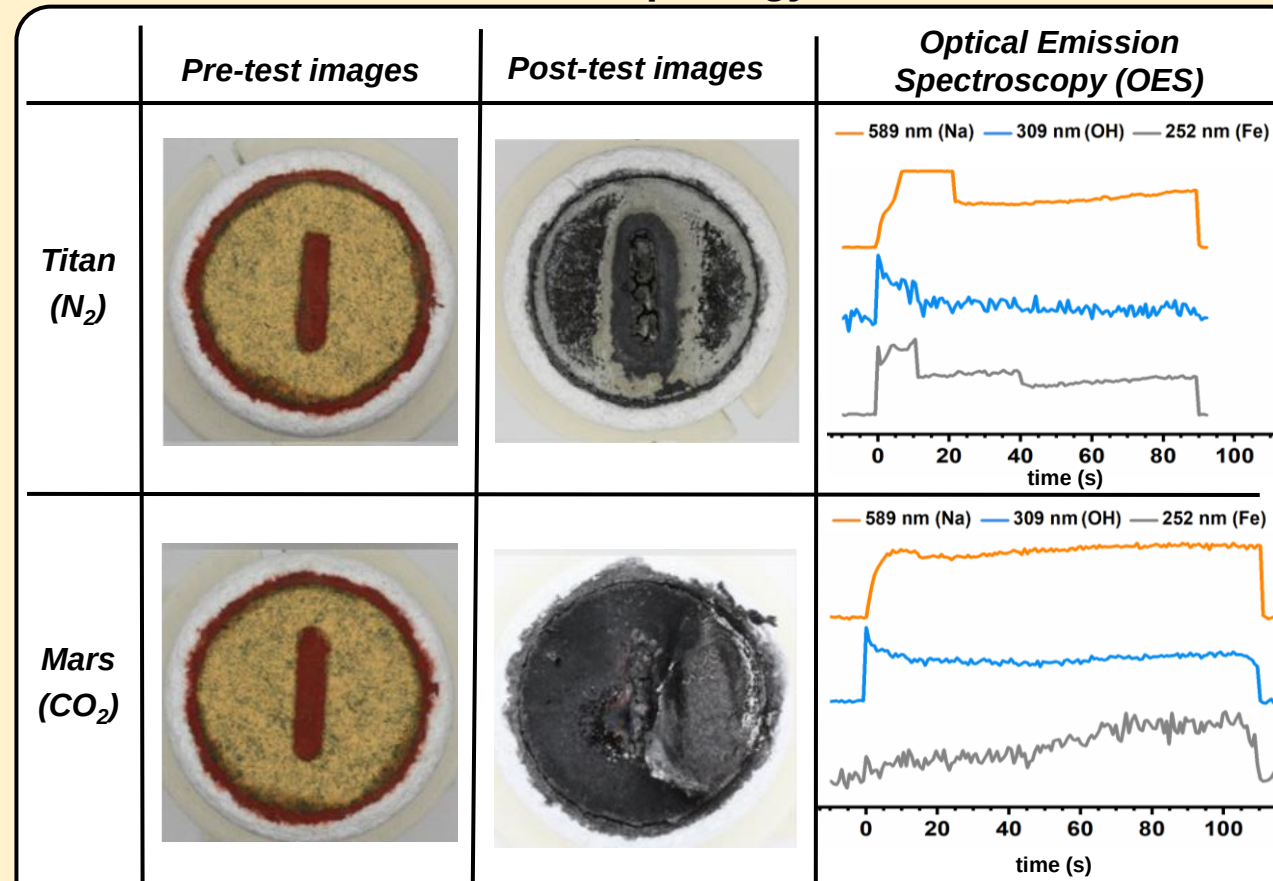


Titan (N₂-2)



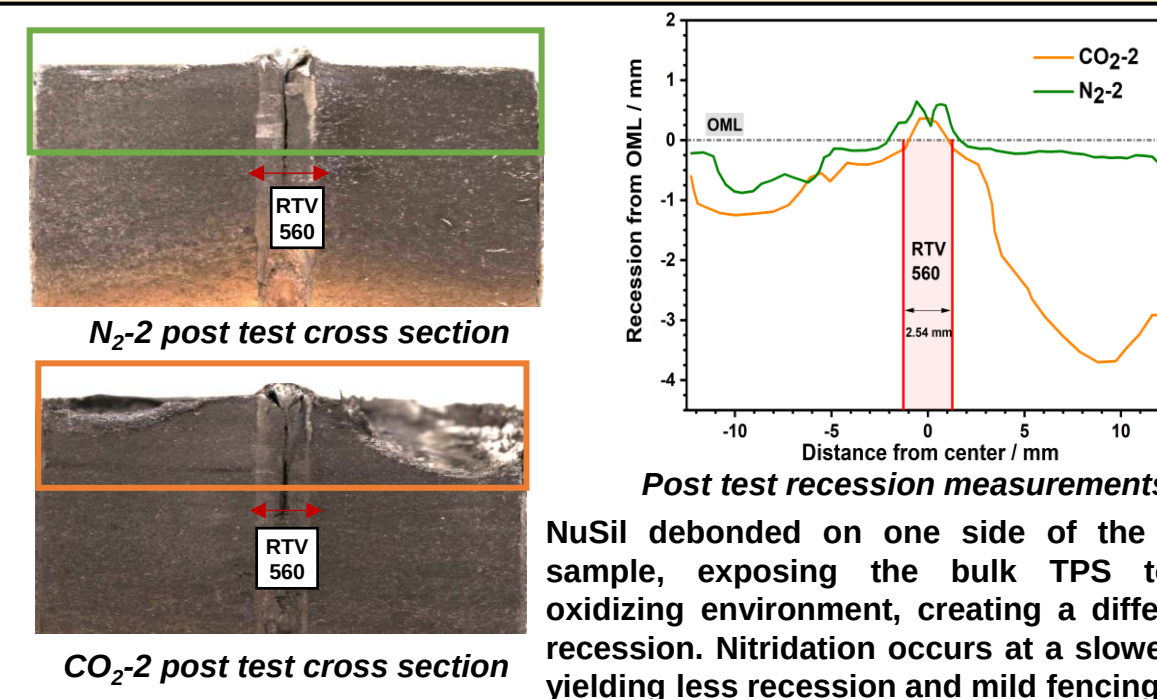
Mars (CO₂-2)

IV. Surface Morphology Results



It can be seen that the NuSil coating remained on the surface of the CO₂ sample and a more defined melt layer was formed for the N₂ sample. Spectra show more iron in Titan relevant (N₂) environments and OH in Mars relevant (CO₂) environments. Melt evolution is shown to impact fencing profiles.

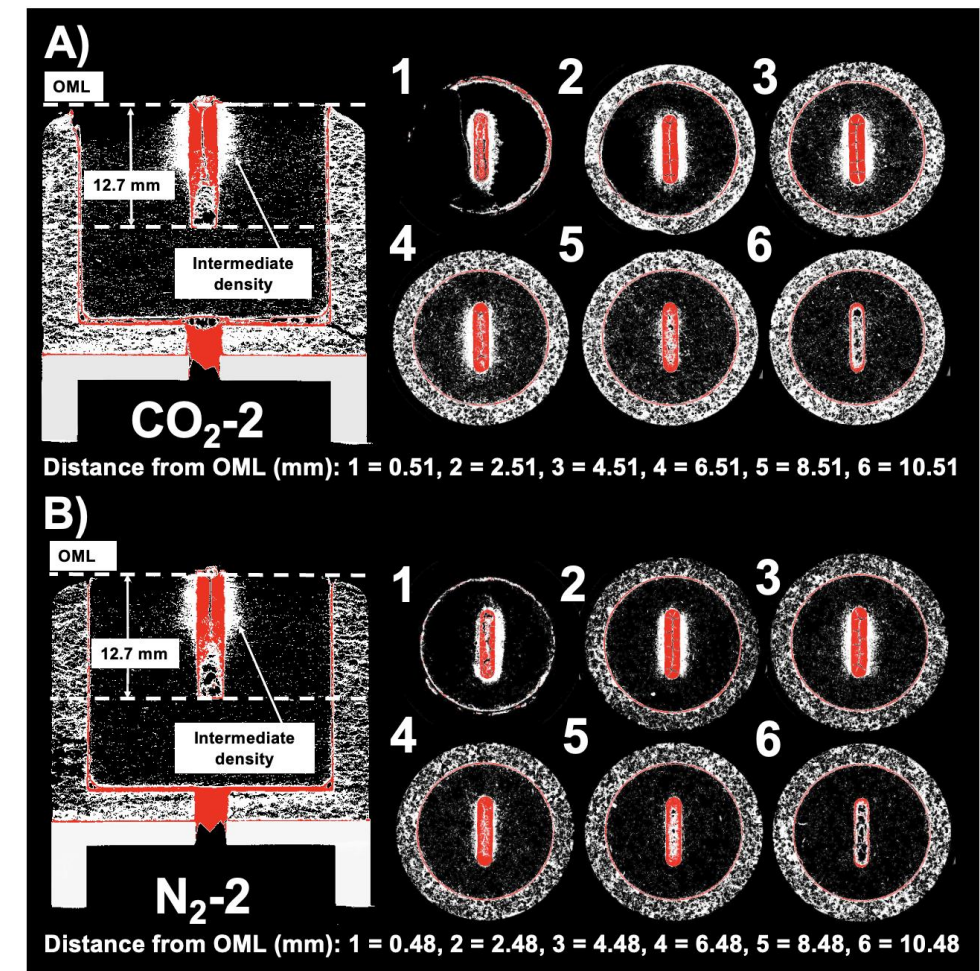
V. Surface Recession Investigation



NuSil debonded on one side of the CO₂-2 sample, exposing the bulk TPS to the oxidizing environment, creating a differential recession. Nitridation occurs at a slower rate, yielding less recession and mild fencing.

VI. Post-Test CT Data

- CT images were taken 2 mm apart at various distances from the outer mold line (OML).
- A region of intermediate density can be seen as a result of RTV wicking into the PICA material. This phenomenon impacts the recession, and therefore the profile of the fence.
- In-depth oxidation could result in increased RTV wicking in environments with CO₂. A crack was also formed in the samples as a result of pyrolysis shrinkage and intumescence.
- The void at the bottom of the RTV gap is assumed to be a result of the manufacturing process



CT data showing in-depth increased density regions

Conclusions

- Several Factors influence the recession profile (fence) in an arc-jet environment. These include:
 - Test condition (Mars/Titan)
 - Melt layer formation (OES products)
 - NuSil integrity
 - RTV sidewall wicking

Future Work

- Testing how differing angles of attack influence the integrity of the developed fence.
- Material response modeling to see cases with:
 - Large samples
 - Differing heating rates

Acknowledgements

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References

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- [3] Pakaya, F., et. al, "Mechanical Properties and Thermal Stability of Epoxy/RTV Silicone Rubber", *IPTEK The Journal for Technology and Science*