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Title

Understanding coke deposition on carbon fibers

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Abstract

Thermal protection systems (TPS) used as spacecraft heat shield encounter extreme temperatures during operation. These materials are typically made of carbon fiber preform impregnated with a phenolic resin. During an atmospheric entry, part of the incoming heat will be absorbed via thermal decomposition of the phenolic resin. Upon thermal decomposition, the phenolic resin generates a wide variety of pyrolysis gases which percolate through the TPS and get ejected into the boundary layer [1].

As the gases travel through the charred material, they may further via homogeneous reactions producing soot, or via catalytic reactions with the fibers, producing solid carbon which deposits on the charred material, known as coking [2]. Methane-rich atmospheres, such as that of Titan, could further increase carbon deposition. This deposition may change the surface topology, affecting heterogeneous reactions such as oxidation or nitridation.

Although this process affects the TPS's ablative performance, it has not been extensively studied. This work proposes a systematic investigation of this process combining experimental characterization and numerical simulations. Carbon deposition is studied experimentally by surface analysis techniques such as scanning electron microscopy, Raman microscopy, or x-ray photoelectron spectroscopy [3]. Numerical work includes simulation at the atomic scales to obtain accurate kinetic rates for lumped models.

References

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