

Analysis of Pyrolysis Products from Ablative Thermal Protection Systems

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NASA's state-of-the-art ablative materials are composed of a three-dimensional network of carbon fibers impregnated with polymers that dissipate thermal energy through pyrolysis. A fundamental understanding of the decomposition mechanisms and pyrolysis product distributions of various classes of polymers is instrumental in the design of new ablative materials. Furthermore, innovative experiments are essential to the continuous modernization of material response models by providing high-fidelity data.

Thus, an apparatus has been designed to measure pyrolysis products from polymers and composite materials by implementing in-situ mass spectrometric techniques. Initial results from experiments performed on siloxane resins and a common phenolic resin will be discussed. Both classes of polymers exhibit heating-rate-dependent decomposition mechanisms. At the onset of heating, phenolic polymers decompose through competitive reactions to form gaseous products and a carbonaceous char. Gas phase products of phenolic resins are typically composed of molecular hydrogen, water, and aromatic hydrocarbons. Pyrolysis products from siloxane polymers include molecular hydrogen, small molecules, and cyclic oligomers from the polymer backbone.