# Post-Flight Assessment of Avcoat Thermal Protection System for the Exploration Flight Test-1

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On December 5, 2014 NASA conducted the first flight test of its next generation human-class Orion spacecraft. The flight was called the Exploration Flight Test -1 (EFT-1) which lasted for 4 hours and culminated into a re-entry trajectory at 9 km/s. This flight test of the 5-meter Orion Crew Module demonstrated various sub-systems including the Avcoat ablative thermal protection system (TPS) on the heat shield. The Avcoat TPS had been developed from the Apollo-era recipe with a few key modifications. The engineering for thermal sizing was supported by modeling, analysis, and ground tests in arc jet facilities.

This paper will describe a postlfight analysis plan and present results from post-recovery inspections, data analysis from embedded sensors, TPS sample extraction and characterization in the laboratory. After the recovery of the vehicle, a full photographic survey and surface scans of the TPS were performed. The recovered vehicle showed physical evidence of flow disturbances, varying degrees of surface roughness, and excessive recession downstream of compression pads. The TPS recession was measured at more than 200 locations of interest on the Avcoat surface. The heat shield was then processed for sample extraction prior to TPS removal using the 7-Axis Milling machine at Marshall Space Flight Center. Around 182 rectangular TPS samples were extracted for subsequent analysis and investigation.

The final paper will also present results of sample analysis. The planned investigation includes sidewall imaging, followed by image analysis to characterize TPS response by quantifying different layers in the char and pyrolysis zones. A full postmortem of the instrumentation and sensor ports will also be performed to confirm no adverse effects due to the sensors themselves. A subset of the samples will undergo structural testing and perform detailed characterization of any cracks and integrity of gore seams. Finally, the material will be characterized with layer-by-layer density measurements and SEM investigations to evaluate material morphology at microstructural level including identification of elements and compounds.