Automated Reflectance Measurement System Designed and Fabricated to Determine the Limits of Atomic Oxygen Treatment of Art Through Contrast Optimization

Atomic oxygen generated in ground-based research facilities has been used to not only test erosion of candidate spacecraft materials but as a noncontact technique for removing organic deposits from the surfaces of artwork. NASA has patented the use of atomic oxygen to remove carbon-based soot contamination from fire-damaged artwork.

The process of cleaning soot-damaged paintings with atomic oxygen requires exposures for variable lengths of time, dependent on the condition of a painting. Care must be exercised while cleaning to prevent the removal of pigment. The cleaning process must be stopped as soon as visual inspection or surface reflectance measurements indicate that cleaning is complete. Both techniques rely on optical comparisons of known bright locations against known dark locations on the artwork being cleaned. Difficulties arise with these techniques when either a known bright or dark location cannot be determined readily. Furthermore, dark locations will lighten with excessive exposure to atomic oxygen. Therefore, an automated test instrument to quantitatively characterize cleaning progression was designed and developed at the NASA Glenn Research Center at Lewis Field to determine when atomic oxygen cleaning is complete.

Reflectance camera with atomic-oxygen-treated painting.

This reflectance camera scans a painting, vertically and horizontally, with a 30-W white light Cole-Parmer Fiber Optic Illuminator System (Cole-Parmer Instrument Company, Vernon Hills, Illinois) and records diffuse reflectance with a UDT Sensors, Inc. (Hawthorne, California) PIN–10DPI photodiode. Each scan consists of a user-defined discrete number of photodiode snapshot readings. The output of the reflectance camera is the average and standard deviation of all the individual diffuse reflectance snapshot readings acquired during a scan. Initially, a soot-damaged painting will have a small standard deviation that will increase as soot is removed. Cleaning will be considered completed when the change in standard deviation between consecutive measurements becomes negative.

A program written in Microsoft Visual C++, developed for operator interaction, controls the scanning process and data acquisition. The program requires an Intel-based PC with a Microsoft Windows 95, 98, or NT 4.0 operating system.

For more information, visit the Electro-Physics Branch http://www.grc.nasa.gov/WWW/epbranch/ephome.htm.

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