Atomic Oxygen Used to Restore Artworks

Painting "Madonna of the Chair" damaged in a 1989 fire at St. Alban's Church in Cleveland, Ohio. Left: Before restoration with atomic oxygen. Right: After restoration with atomic oxygen.
The left side of the split image shows charred fire damage on the painting. The right side shows the restored color and image.

Techniques developed at the NASA Glenn ResearchCenter to produce atomic oxygen in order to simulate the low-Earth-orbit environment for spacecraft materials testing can also be applied in the field of art restoration. Defaced or fire-damaged artwork can be treated with atomic oxygen to remove the damage and enable restoration that could not be accomplished with conventional methods. The process has been patented (U.S. Patents 5,560,781 and 5,693,241) and has been used to restore several works of art.

Atomic oxygen reacts readily with compounds containing carbon, typically converting them to carbon monoxide or carbon dioxide, which leaves as a gas from the surface in trace amounts, making the process more environmentally "green" than traditional solvent cleaning techniques. The reaction is generally limited to the surface such that penetration of the atomic oxygen into the underlying surface is improbable. When artwork is damaged in a fire or defaced using pencil, crayon, some types of pen, or lipstick, there is typically a layer of carbon-containing material on the surface that a conservator wishes to remove without disturbing the underlying pigments. In many cases of fire damage, the paint binder intermixed with the pigment underneath the layer of soot can be charred as well. Unless this is removed, the paint pigment cannot be made visible and the artwork will remain dark and for the most part featureless. The use of atomic oxygen to treat the artwork allows soot, char, and other unwanted marks to be gently removed through chemical reaction in a dry, noncontact process. Since most of the paint pigments are oxides or metal complexes that are already oxides or are not as easily oxidized as carbon, the chemical reaction slows

or stops when the paint pigment becomes exposed. In many cases this allows the removal of charred binder from between pigment particles, thereby allowing the surface to be restored to the point that a replacement binder can be applied by a conservator to bring the painting back to near its original state. Surfaces with organic pigments can be treated through careful timing of the exposure to atomic oxygen and/or masking so as not to remove too much of the pigment.

Atomic oxygen treatment provides a way in which many artworks, believed to be unrecoverable by conventional wet chemical techniques, can be restored to again allow the art to be viewed, studied, and enjoyed. The ability to restore artwork treasured by cultural groups and to restore national art treasures allows cultural history to be preserved and provides great benefit to the public. This technology was given the R&D 100 Award for 2002 and was selected for the "best of the best" of the 2002 R&D 100 award winners, receiving the Editor's Choice Award for Most Innovative New Technology.

Find out more about this research: http://www.grc.nasa.gov/WWW/epbranch/

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Headquarters program office: OAT (TTPO)
Programs/Projects: Microgravity Science for cleaning of contaminants from experiment hardware, cleaning of spacecraft surfaces by removal of organics or biocontaminants
Special recognition: 2002 R&D 100 Award 2002, The Best of the Best of the R&D 100--Editor's Choice Award for Most Innovative New