

part, authentication can be attained with a simple scan. For those who have ever tried to put a barcode inside a pearl, ECPIAS may sound like a good alternative.

This work was done by Harry F. Schramm of Marshall Space Flight Center, and

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In accordance with Public Law 96-517, the contractor has elected to retain title to this invention. Inquiries concerning rights for its

commercial use should be addressed to:

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Refer to MFS-31890, volume and number of this NASA Tech Briefs issue, and the page number.

Vacuum Attachment for XRF Scanner

A greater range of elements could be analyzed.

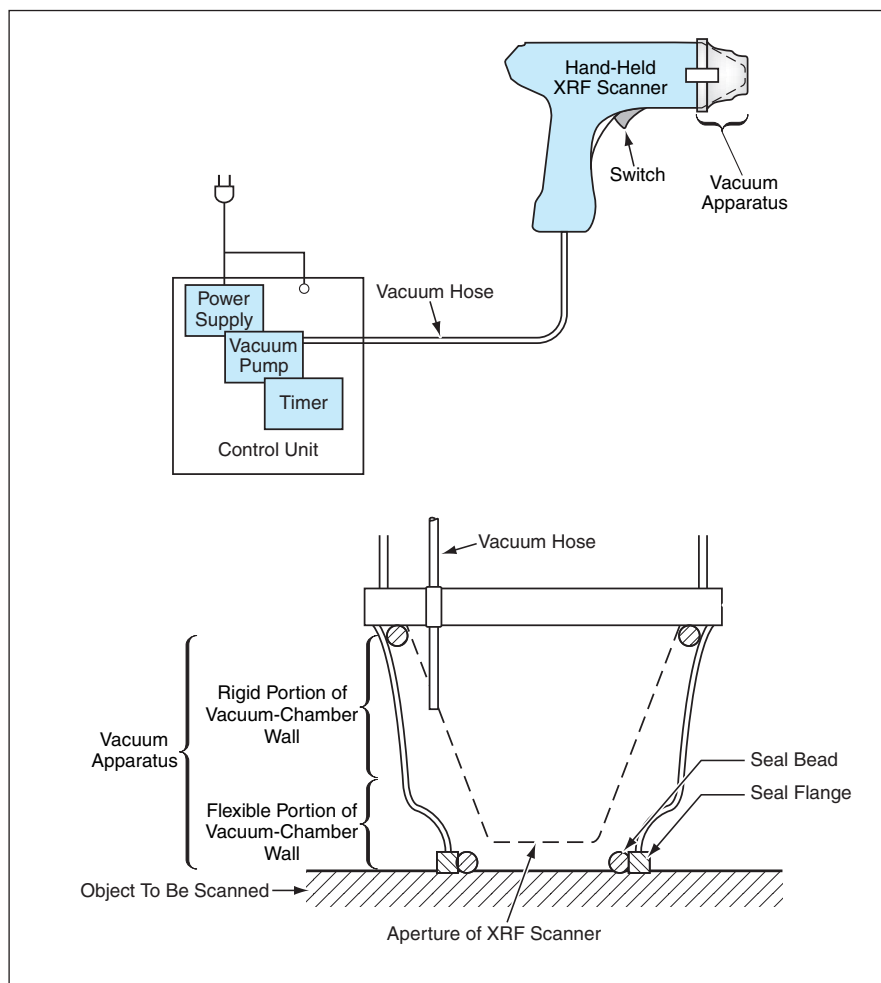
Marshall Space Flight Center, Alabama

Vacuum apparatuses have been developed for increasing the range of elements that can be identified by use of x-ray fluorescent (XRF) scanners of the type mentioned in the two immediately preceding articles. As a consequence of the underlying physical principles, in the presence of air, such an XRF scanner is limited to analysis of chlorine and elements of greater atomic number. When the XRF scanner is operated in a vacuum, it extends the range of analysis to lower atomic numbers — even as far as aluminum and sodium. Hence, more elements will be available for use in XRF labeling of objects as discussed in the two preceding articles.

The added benefits of the extended capabilities also have other uses for NASA. Detection of elements of low atomic number is of high interest to the aerospace community. High-strength aluminum alloys will be easily analyzed for composition. Silicon, a major contaminant in certain processes, will be detectable before the process is begun, possibly eliminating weld or adhesion problems. Exotic alloys will be evaluated for composition prior to being placed in service where lives depend on them. And in the less glamorous applications, such as bolts and fasteners, substandard products and counterfeit items will be evaluated at the receiving function and never allowed to enter the operation.

Both hand-held and tabletop XRF portable scanners have been developed. The vacuum apparatus is compact and lightweight and does not detract from the portability of either XRF scanner. It is attached to and detached from the aperture end of either XRF scanner.

The upper part of the figure schematically depicts the hand-held XRF scanner. The XRF scanner and vacuum apparatus would be connected to a portable (belt-mounted) control unit that would contain



A Compact Vacuum Apparatus attached to the aperture end of a hand-held XRF scanner would enable vacuum XRF analysis without the need to mount the entire XRF scanner in a vacuum chamber.

a power supply and a vacuum pump. The lower part of the figure is a simplified, enlarged cross-sectional view of a vacuum apparatus attached to the aperture end of the XRF scanner. The side wall of the vacuum apparatus would include a flexible portion that would support a seal flange and seal bead, which would be pressed against an object to be scanned to form an air-tight seal. While holding the seal and

pressing the aperture of the XRF scanner against the object to be scanned, the operator would press a switch, thereby starting the process. The switch would turn on the pump and keep it on for as long as needed to maintain the vacuum needed for the XRF scan.

The vacuum enhanced version of the hand-held XRF, already in use in the shuttle program, takes the chemistry lab

to the shop floor, something that was not practical to do before with large products such as external tanks, space shuttle main engines, and solid rocket boosters. From label scanning to material analysis, the vacuum enhanced XRF is a welcome addition to the NASA toolbox of capabilities.

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Refer to MFS-31898, volume and number of this NASA Tech Briefs issue, and the page number.

Simultaneous Conoscopic Holography and Raman Spectroscopy

Both the topography and the chemistry of surfaces would be mapped.

NASA's Jet Propulsion Laboratory, Pasadena, California

A new instrument was developed for chemical characterization of surfaces that combines the analytical power of Raman spectroscopy with the three-dimensional topographic information provided by conoscopic holography. The figure schematically depicts the proposed hybrid instrument. The output of the conoscopic holographic portion of the instrument is a topographical map of the surface; the output of the Raman portion of the instrument is hyperspectral Raman data, from which the chemical and/or biological composition of the surface would be deduced. By virtue of the basic principles of design and operation of the instrument, the hyperspectral image data would be inherently spatially registered with the topographical data.

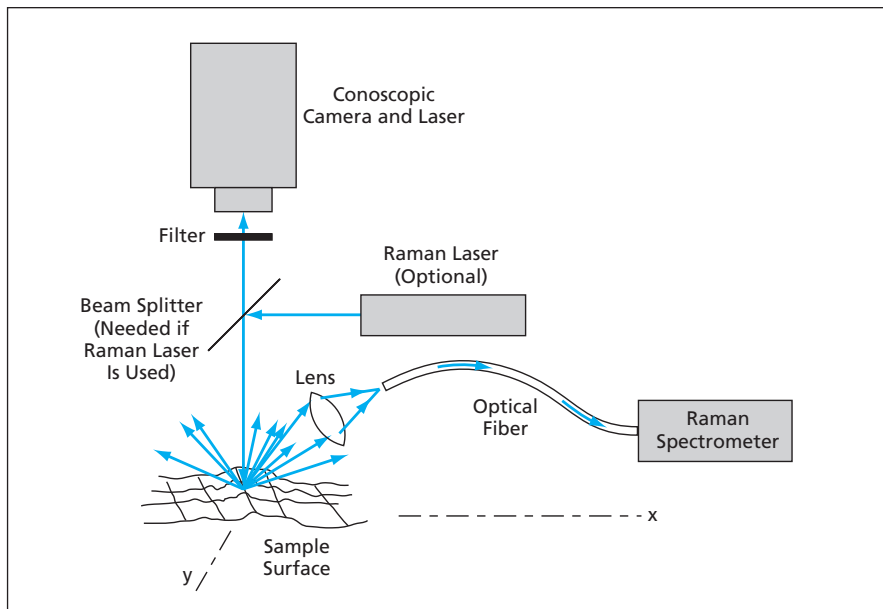
In conoscopic holography, the object and reference beams of classical holography are replaced by the ordinary and ex-

traordinary components generated by a single beam traveling through a birefringent, uniaxial crystal. In the basic conoscopic configuration, a laser light is projected onto a specimen and the resulting illuminated spot becomes a point source of diffuse light that propagates in every direction. The laser beam is raster-scanned in two dimensions (x and y) perpendicular to the beam axis (z), and at each x,y location, the pattern of interference between the ordinary and extraordinary rays is recorded. The recorded interferogram constitutes the conoscopic hologram. Of particular significance for the proposed instrument is that the conoscopic hologram contains information on the z coordinate (height) of the illuminated surface spot. Hence, a topographical map of the specimen is constructed point-by-point by rastering the laser beam in the x and y directions and

correlating the x and y coordinates with the z information obtained from the interferograms. Conoscopic imaging is an established method, and conoscopic laboratory instruments for surface metrology are commercially available.

In Raman spectroscopy of a surface, one measures the spectrum of laser light scattered inelastically from a laser-illuminated spot on the surface. The wavelengths of the inelastically scattered light differ from that of the incident laser beam by amounts that correspond to the energies of molecular vibrations. The resulting vibrational spectrum can be used to identify the molecules. Raman spectroscopy is a standard laboratory technique for identifying mineralogical, biological, and other specific chemical compositions.

In the design and construction of the proposed instrument, a commercially available laboratory conoscopic holographic imaging system would be integrated with a Raman spectrometer (see figure). The on-axis back-scattered laser light would be used by the imaging system to generate the conoscopic hologram of the illuminated spot. Part of the off-axis back-scattered laser light would be collected by a lens, which would couple the light into an optical fiber, which, in turn, would feed the collected light to the Raman spectrometer. The lateral (x,y) resolution of the instrument would typically be of the order of microns, the exact value being determined primarily by the size of the laser-illuminated spot on the specimen. In one of two configurations, the Raman-excitation and conoscopic-holography beams would be generated by two different lasers and would be aligned and focused together on the same spot on the specimen. In a simpler configuration that would entail less weight, complexity,



A Spot on a Specimen Would Be Illuminated by a laser beam (or by two coincident laser beams) that would be raster-scanned across the surface in x and y . Laser light back-scattered from the surface would be used to map the surface height (z) and chemical composition as functions of x and y .