Cleaning Natural History Material with Lasers

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Laser cleaning in conservation is a relatively recent technological advance. The selective and highly controlled removal of surface contaminants is generally accepted as a major advantage over conventional cleaning methods. The Palaeontology Conservation Unit of the Natural History Museum in London is currently evaluating the use of a Q-switched Nd:YAG laser on natural history material.

The term LASER is an acronym for Light Amplification by the Stimulated Emission of Radiation. The light produced is monochromatic and the beam is highly focused (collimated). Lasers are produced in a variety of forms and the available wavelengths range from ultraviolet to infrared.

In 1999 a Joint Research Equipment Initiative was set up between the Natural History Museum, Imperial College of Science, Technology, and Medicine, the Victoria and Albert Museum, The Royal College of Art and the Tate Gallery. This has enabled the institutions involved to jointly acquire a dual wavelength laser, equipment, which would have been prohibitively expensive under normal circumstances.
The group chose the Q-switched Nd:YAG dual wavelength laser, as it is the most commonly used laser for cleaning laser conservation. It has been in development since the mid-1960's and is perceived by users as a very reliable and compact tool. The beam delivery is via a multi-jointed, articulated arm or through optical fibres, with a handpiece for the user to direct the beam onto the object. The laser emits the most appropriate wavelength and energy of radiation for selective cleaning of a wide variety of surfaces. The Nd:YAG laser is currently used by conservators for cleaning a range of materials; for infrared cleaning (λ1064nm) materials such as marble, sandstone, terracotta, plaster, ivory, bone, parchment and limestone have been successfully treated. For visible green (λ 533nm), cleaning work has concentrated on artifacts such as paper, stained glass and paintings.

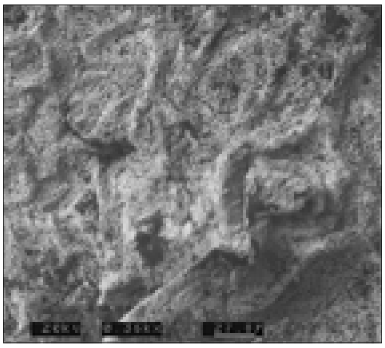
A Q-switched laser is found to be very effective for cleaning natural history samples. The Q-switch acts as an extremely high-speed shutter and shortens the pulse length of the laser. This results in an extremely intense pulse of energy with very short pulse duration. The short pulse length ensures little or no temperature rise in the underlying surface and, therefore, little risk of thermal damage.

Herbarium sheets were treated in the past with mercuric sulphide in order to prevent pest attack. Over time this coating oxidises and leaves a black residue. The remaining contaminant can still be seen imprinted on the opposite sheet.

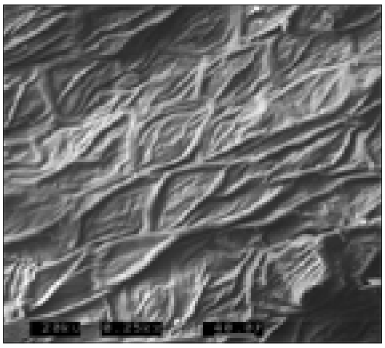
The main advantages of laser cleaning over more conventional cleaning methods are:
Minimum contact - the energy is delivered as light so there is no mechanical contact with the object surface, thereby allowing the treatment of fragile surfaces.

Localised - the laser will only clean where the beam is directed. The beam size can typically range from less than a millimetre to a spread of one centimetre making it a precise tool.
Selective - the energy from the laser is monocromatic. By choosing an appropriate wavelength that is strongly absorbed by the layer to be removed, and only weakly absorbed by the underlying surface, selective cleaning is possible.
Control of cleaning - once the laser has been switched off the cleaning process stops immediately.

Selection and Procedure
Samples from duplicate collections are selected for cleaning on the basis of one or more criteria; accumulation of dust, encrustation (physical or biological), chemical degradation or alteration and importantly that none of the samples were suitable for conventional or more established cleaning methods. An initial examination and record of the condition of the sample is made and images are taken. Test areas are cleaned using the laser, using different pulse rates and focal distances. A number of successful tests have been carried out on a variety of natural history objects (Cornish and Jones 2002) for example the leaf of the herb *Silene inflata* - removed from a herbarium sheet. It was found covered in a black pollutant suspected to contain mercury. The dried leaf sample had been treated during the 19th Century with mercuric sulphide as a method to prevent insect infestation. Many herbarium sheets show the presence of this black surface coating. Subsequent testing of the leaf surface by x-ray diffraction identified the pollutant as metacinnabar (mercuric sulphide, HgS). There is no established cleaning technique available plus there are Health and Safety considerations.
Treatment with the laser has readily removed the metacinnabar but left the leaf sample intact. This can be shown through the preservation of cellular structures in the desiccated leaf, e.g. veining and stoma.
Current work involves the removal of conductive coatings on microfossils and removal of surface pollutants from bird's eggs. Watch this space!!



Study under SEM shows the leaf before cleaning...



...and after.

Cornish, L, and Jones, C. 2002, 'Laser cleaning of natural history specimens and subsequent SEM examination', *Conservation Science 2002*. Edited by Townsend, J., Eremin, K., & Adriaens, A, Archetype 101-106.