LASER CLEANING: THE RESTORATION OF A FIRE-DAMAGED COTTAGE

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Amongst other things, laser cleaning can be used to conserve and restore important works of art, architecture, and cultural heritage. This article describes the application of laser cleaning to restore parts of an old stone cottage and its artefacts in a remote area of South West Ireland. The cottage was built on the side of a mountain overlooking the Atlantic Coast, around 1900. Because organic farming is practiced around the two acre plot, the use of chemicals was not permitted during the restoration process.

Cause of the fire damage

The cottage had no foundations, which was common at the time of building, with walls 2 feet thick, made of large stones. There was no insulation in the walls nor the floors, and so dehumidifiers were constantly in use, especially in winter. Unfortunately, one of these dehumidifiers overheated and caught fire, smothering the whole house in a thick black sooty residue. All the outside windows were closed and the fire quenched itself shortly after ignition, either by consuming the oxygen supply in the house, or being dampened by spilled water from the melted reservoir tank in the dehumidifier. Luckily the house was unoccupied at the time, but considerable internal damage had been caused by the black acrid smoke that travelled to all parts of the house, covering clothing and linen, shower ties, shoes, pottery, carpets, memorabilia, ceilings, etc. in a thick, black residue.

Work began on restoring the cottage to its original state. Even if the use of the strongest industrial grade detergent had been permitted, one could not “wash” the entire inside of the house.The partitions upstairs had to be removed as the black soot got in between the slats. The attic also had to be taken down and, bearing in mind nobody had been up there for over a century, a lot of dust and rotten wood came with it. After removing the entire contents of the house and the partitions, there was actually very little remaining to clean.

Laser cleaning the fabric of the building

The battens in the room in which the fire started were a cause for concern. Only one of them was burned (the one directly over the burning dehumidifier) but the rest were coated in the sooty residue. Over the years, the battens had been painted and repainted so the soot could not penetrate the wood. Should all the battens

Figure 1: Saving the ceiling battens

need replacing, the upstairs floor, which was attached to the battens, would have to come down too. The cost for doing this would be quite considerable.

In order to avoid this, laser cleaning was employed and was able to remove the soot, both from the painted battens, and the plaster board, (which incidentally saved the whole house from being burned to the ground as the plaster boards have a 20 minute burn-through time) (Figure 1).

During the cleaning process we used our P-Laser Compact CQF 100 W hand-held portable fibre laser (Figure 2) at full power, with a programmable line width of 200 mm and adjusted the focal length to the maximum of 500 mm. This gave the largest spot, thus the lowest energy density per pulse, at a repetition rate of approximately 100 kHz. Extraction was essential as without it, the soot that had been removed would land at another location in the house during the cleaning process. In addition, the operator wore a mask respirator, which was suitable for organic vapours and laser fumes. No heat was generated during the cleaning process. The laser wavelength was absorbed into the black soot on the battens and walls and reflected off the white paint. The soot was also removed from the brown painted battens, which was thick enough to ablate a few microns of brown paint. The battens were ready for immediate repainting afterwards.

The same was true for removing the black soot on a painted door. Here the white paint, just like on the walls, reflected the beam completely. Figure 3 shows that all the soot on the wall, hinge and door was removed. The common feature for the walls, woodwork and metal hinges was that they were all painted white. White paint

Figure 2: The 100 W Compact laser. Transparent film was wrapped around the laser and fibre delivery cable to protect them from the soot.

can be difficult to remove using laser cleaning. Generally darker colours tend to absorb the beam more easily than lighter colours, although this is more of a guide that a rule. It is the chemical composition of the pigments in the paint that ultimately determines the success of the ablation.

Restoring artefacts

Most artefacts in the house were lost. The cottage was a holiday home for an elderly couple and there were a lot of photographs, books and artwork of sentimental value that were destroyed. Also lost were electrical items such as the fuse box, telephone, TV and radios, because soot is conductive. Only a few metal objects, glassware and cooking ware that had a strong paint or varnish on their surface were saved as the soot did not penetrate into them.

Most items on the kitchen dresser were badly damaged, as shown in Figure 4. Even the contents inside the drawers and cupboards were covered with fine particles of soot. Laser

Figure 3: The laser beam was reflected off the white plaster boards and white painted walls, while at the same time removing the soot.

Figure 4: Smoke damaged items on kitchen dresser.

cleaning could be carried out any metal or ceramic artefact on the dresser. The Delft pottery on the dresser was old and more ornamental than practical. Normal washing detergent was not strong enough to break down the hydrocarbon chemical bonds in the soot. We were not permitted to use anything stronger than domestic washing-up detergent which had to be eco-friendly.

To clean the Delft, the laser was brought outside and set up on the front garden patio. Windy conditions meant that no extraction was required. The following images show the

Figure 5: Before and after images of cleaning Plate 1.

pottery before and after laser cleaning. The plate depicting St. Patrick (Figure 5) was laser cleaned using the same parameters employed for removing the soot from the battens and plasterwork. The image of St. Patrick and the text on the plate were printed over the top of the glaze and it appears that some of the paint was removed by the action of the laser. Perhaps with softer parameters, i.e. 30% energy per pulse, instead of 100% (1 mJ), this may not have been the case.

We changed the profile of the beam from a line to a circular scan for the next plate (Figure 6). The words “New York City” were slightly faded by the action of the laser because once again the print was on top of the glaze. Round the circumference of the plate there were splashes of red paint. None of this faded because the red paint was under the glaze and thus protected against the laser beam.

The milk jug in Figure 7 was restored to a usable condition. Initially the pattern on the jug could not be seen, but with one sweep of the beam it was revealed. We did hear some of the glaze started to “ping” and tiny micro cracks were visible. The jug already exhibited quite a large number of mini cracks in the glaze and the beam may have been diffracted into these cracks.

Conclusion

In conclusion, our 1 micron, 100 ns, 1 mJ, 100 kHz fibre laser was excellent at removing the soot from the painted battens, plaster board, and white painted walls. No soot remained after several passes of the laser beam and repainting could be carried immediately afterwards. In relation to cleaning the ceramic glazed Delft, the soot was easily removed and if the print was on top of the glaze, it faded slightly. We would recommend that a beam homogeniser, which gives a “top hat” beam profile shape, would benefit in this application although very soft parameters may have been as good.

Overall the project was a success. Originally the battens in the kitchen were scheduled for replacement but the action of laser cleaning allowed them to be saved, except one which was badly burned. This may be of interest to loss adjusters employed by insurance companies to assess large or complex claims, where perhaps laser cleaning might find a new role.

As Art Schawlow, inventor of the laser said, the laser “is a solution looking for a problem” and I think we may have yet again discovered another application for laser technology. To see the laser cleaning videos associated with this article, please visit our YouTube channel www.laserage.tv.

Figure 6: Before and after images of cleaning Plate 2.

Figure 7: Before and after images of cleaning a milk jug.

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