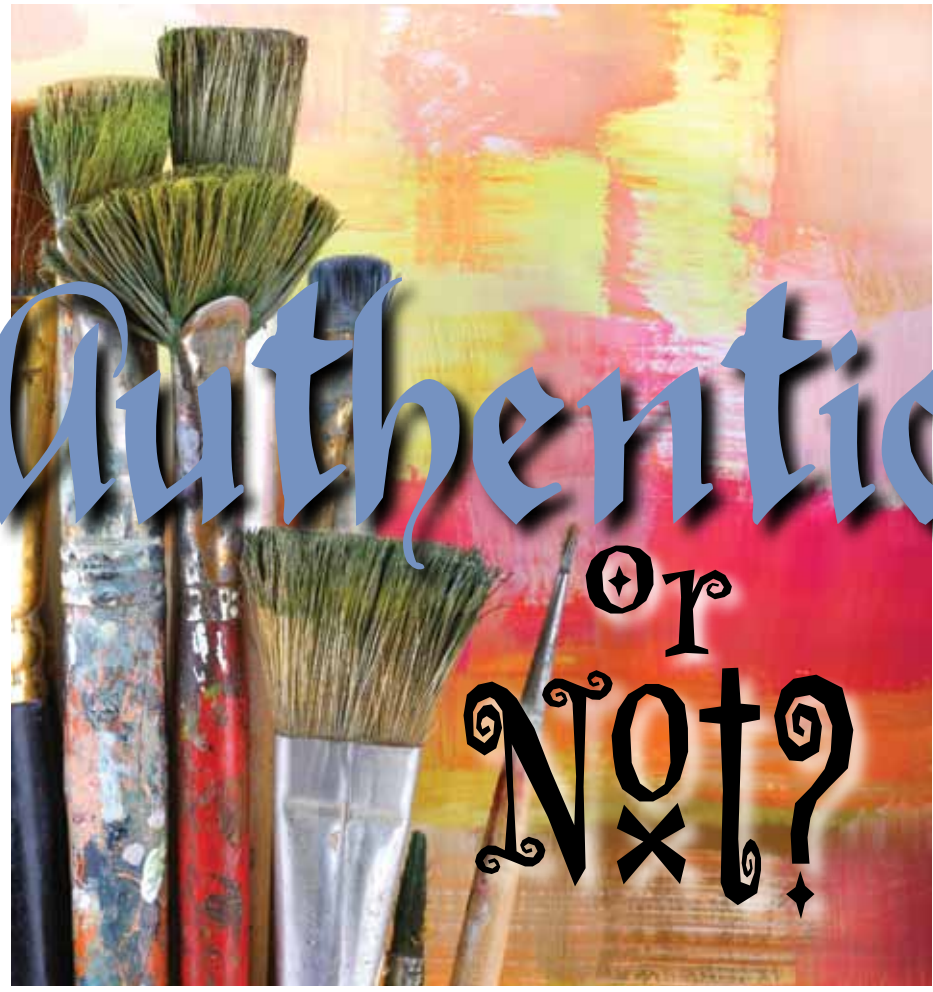


ISTOCK

Chemistry Solves the Mystery

By M. Rae Nelson

In 1927, a German art dealer named Otto Wacker convinced art experts that he had 33 paintings by Dutch painter Vincent van Gogh. Wacker planned a major van Gogh exhibit in which the paintings were to be sold.

A few days before the exhibition, all the paintings were hung, with the exception of four that had yet to be received from Wacker. When the last four arrived, they were placed next to their assigned positions on the floor. At that moment, Grete Ring, the general manager, saw the paintings and stopped dead. Something about them didn't look right. Could these pieces be forgeries?

Ring and Walter Feilchenfeldt, the managing director of the firm holding the exhibit, agreed that all four were fakes. The paintings were removed from the exhibit just in time. But then, Ring and Feilchenfeldt wanted to take a closer look at the other 29 paintings.

For the next 5 years, art experts, art dealers, museum curators, and others carefully studied the 33 paintings attributed to van Gogh. In 1932, Wacker was found guilty of fraud and sentenced to 19 months in prison.

The "Wacker case"—as it is now called—is one of the most famous frauds in art history. It highlighted the amazing ability of forgers to fool art experts, let alone the general public, about the authenticity of a piece of art. Although art forgery was not new at the time, this case revealed how skilled forgers were in deceiving almost everyone. But this case also allowed the development of scientific techniques, many based on chemistry, to examine paintings at the molecular level and determine whether they were the "real deal."

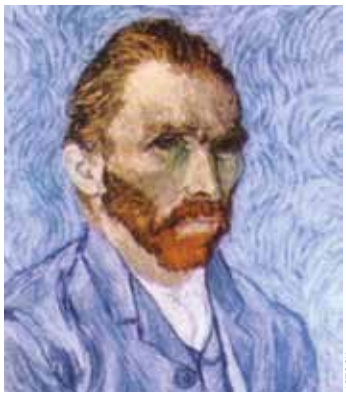
Finding a forgery is like solving a forensic puzzle. Art experts and police work closely with scientists to find forgeries and forgers. The stakes are high. After a chemical analysis, a piece of art worth millions of dollars one day can be rendered almost worthless the next.

How can scientists help spot the forgeries? The cases of two paintings, one named F614 that was attributed to van Gogh, and another attributed to abstract expressionist painter Jackson Pollock, show that it takes a substantial amount of detective work to determine whether a painting is authentic.

Underneath the van Gogh F614

Although Wacker was charged with fraud and sent to prison, the experts who had examined his paintings disagreed over which paintings were authentic and which ones were not. As a result of this uncertainty, the authenticity of many of the paintings that were sold is still not established.

Two siblings, Monica and Michael de Jong, inherited one of these paintings after their parents had bought it in 1932. In 2000, they wanted to solve the mystery, once and for all. So, they brought the painting, named F614, to Marie-Claude Corbeil, a chemist at the Canadian Conservation Institute in Ottawa.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Self-portrait of artist Vincent van Gogh

The first thing Corbeil did was to look at the canvas. From letters between van Gogh and his brother, Theo, art experts know that van Gogh used an "asymmetrical" canvas, which contains a different number of horizontal and vertical threads. The canvas of F614 had been lined to help protect it, sealing it from a visual inspection. "The only way we could 'see' the canvas was to do an X-ray," Corbeil said.

BOTH PHOTOS: © CANADIAN CONSERVATION INSTITUTE, OTTAWA, CANADA

The painting known as F 614

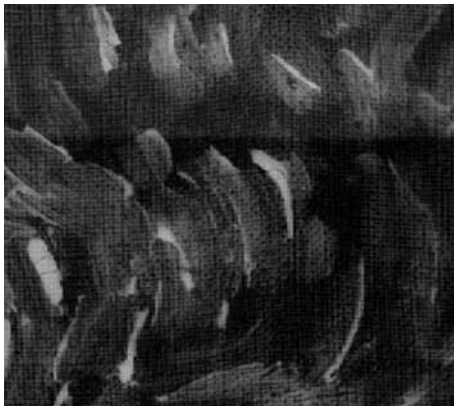

Figure 1. Magnified X-ray image of part of the top right section of the F614 painting, showing not only the detail of the brushstrokes on the painting but also the canvas underneath (fine horizontal and vertical lines visible when looking closer at the painting).

X-rays are a form of electromagnetic radiation that is invisible to our eyes. Targeting X-rays onto a painting is similar to the technique doctors use to look inside our bodies and spot broken bones. An X-ray film captures the radiation passing through the body, creating darker areas where the X-rays go through and lighter areas where most of the X-rays are absorbed.

Similarly, X-rays that are projected toward a painting are not absorbed by materials containing light elements and are absorbed by materials made of heavier elements. The canvas is composed of threads made of a fabric that does not absorb X-rays. However, in many paintings, the canvas is covered by a priming layer. The purpose of this layer is to make the surface of the canvas smoother. So, when X-rays go through the painting (assuming that the painting itself does not absorb the X-rays), they are absorbed by this underlying layer, also called a ground layer.

But when this ground layer presses on the threads of the canvas, it fills the space between the threads, so it becomes thicker in the spaces between threads and thinner where the threads overlap. "The way this ground layer presses on the threads is similar to pressing mud against a metal grid," Corbeil says. "When you remove the grid, all you see is the imprint of the grid on the mud. In the case of the painting, when you look at the X-ray image, all you see is the imprint left by the threads on the ground layer."

The F614 painting was placed in an isolated, lead-lined room, in front of a sheet of radiographic film. For 10 minutes, X-rays were focused onto the painting. The image that emerged showed that the canvas contained the same number of threads in the horizontal and vertical directions (Fig. 1). This result showed that the canvas used for the F614 painting could not have been used by van Gogh.

This was the ultimate evidence that the de Jong siblings needed. Although it meant that their painting was worthless, it answered the question they had had for many years.

The Pollock case

Another famous case concerned 32 paintings attributed to artist Jackson Pollock (1912–1956). Pollock was a major figure in the abstract expressionist movement, an American art form of the 1950s. But after the artist died, many pieces attributed to him started surfacing, most of which have been found not to be authentic.

In 2005, an art dealer named Mark Borghi announced the discovery of 32 paintings by Jackson Pollock. Not surprisingly, many art experts viewed these paintings with suspicion.

The paintings were found in 2003 by Alex Matter, the son of graphic artist and photographer Herbert Matter and the painter Mercedes Matter, who were friends of Pollock and his wife, Lee Krasner. The pieces were estimated to have been in storage for more than three decades.

To help establish the authenticity of these paintings, Matter contacted James Martin, an expert at Orion Analytical LLC, a company located in Williamstown, Mass., that specializes in the examination and analysis of various items, from ancient Egyptian artifacts to paintings to printed circuit boards.

Using a surgeon's scalpel, Martin carefully removed paint chips, some only the width of a strand of hair. Then, he used a technique called Fourier-Transform Infrared (FTIR) microspectroscopy to identify the chemical compounds present in the paint chips. Spectroscopy helps scientists identify compounds based on how they interact with radiation of a known wavelength.

The radiation used in the FTIR technique is infrared light—the type of light emitted by heat lamps that warm food. When molecules absorb infrared light, they vibrate at frequencies that depend on their chemical structure and composition. By looking at how infrared light is absorbed by a sample, scientists can determine the nature of the sample.

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Jackson Pollock painting *Autumn Rhythm: Number 30, 1950.* Photograph by Hans Namuth.

Here is the basic concept behind this technique: The bonds between atoms in a molecule act as if the atoms were connected by a spring. For instance, imagine that two balls are connected by a spring and that we stretch the spring. Upon release, the two balls vibrate back and forth at a regular frequency determined by the "strength" of the spring.

Two bonded atoms behave in a similar manner. Depending on the strength of the bond, the atoms will vibrate more or less rapidly. Strong bonds between light atoms are like small balls linked by a stiff spring: They vibrate rapidly, corresponding to a high frequency. Weaker bonds between heavier atoms act like heavy weights on a floppy spring and absorb lower frequency light.

In the case of the Matter paintings, Martin recorded these spectra and then compared to reference spectra for known materials. Each spectrum is like a person's fingerprint. Every chemical compound produces its own infrared spectrum, which is different from the spectra of other compounds.

When Martin compared the spectra of samples from the paintings to those of known pigments, he found that many did not match with pigments that Pollock could have used. This meant that some of the paints in the Matter pieces did not exist in the artist's lifetime.

In 10 of the Matter paintings, pigments plucked from various layers of the paintings matched pigment Red 254, also known as "Ferrari red" (Fig. 2) which was patented in the early 1980s, well after Pollock had died.

"Finding that Ferrari red was the 'Aha!' moment," Martin said. "It was strong evidence that those pieces were not created by Jackson Pollock."

It is important to note that the paintings studied by Martin did not bear Pollock's signature. So, although the paintings may not have been created by Pollock, the person or persons who painted them might have simply imitated Pollock's style without intending to falsely attributing them to him. If that is the case, these paintings would not be forgeries.

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This painting is attributed to the famous painter Jackson Pollock, but its authenticity has been debated since its discovery among 32 works of art by Alex Matter, the son of photographer Herbert Matter, who was a good friend of Pollock.

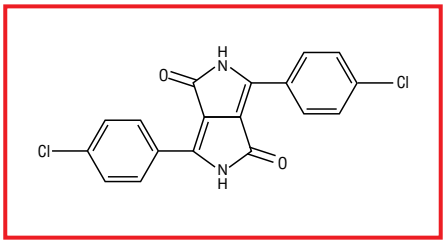

Figure 2. Chemical structure of pigment Red 254

Molecules containing more than two atoms vibrate at different frequencies. For example, a water molecule (H_2O) contains three atoms connected through two O–H bonds, and these two bonds make a 104.5-degree angle when the water molecule does not move. When the water molecule absorbs infrared light, each bond can vibrate back and forth or the bond angle can open and close around 104.5 degrees.

Because the structure of every molecule is unique, the frequencies at which the atoms in the molecule vibrate are equally unique. As a result, each kind of molecule has its own characteristic pattern of light absorption at different frequencies, which can be recorded as a series of peaks and valleys.

A thriving market

Many works of art keep appearing suddenly and inexplicably decades after the death of their presumed creators. Thanks to the many techniques now available, it is often possible to subject such pieces of art to close scrutiny and determine whether they are authentic.

But there will always be art dealers and collectors who can be fooled. Take the case of Ely Sakhai, a New York art dealer who, for close to a decade, ran one of the most audacious forgery scams ever. He would buy a little-known painting by a famous painter, fake it, and then sell the fake and real paintings, the first in Asia and the second in New York or London. In total, his operation grossed $3.5 million, according to the U.S. Federal Bureau of Investigation (FBI).

Unfortunately for him, a buyer of one of the fake paintings from Tokyo and a buyer of the real copy from New York decided to sell them at the same time through Christie's auction house in New York. The FBI traced the history of the fake, and Sakhai was arrested.

In April 2010, the National Gallery in central London organized an exhibit displaying all the fake paintings that it had acquired over the past two centuries. The exhibit displayed more than 40 such paintings!

Next time you hear about a newly discovered painting by some famous artist, be prepared to question its authenticity. And chances are, techniques based on chemistry will provide the answer.

Check out the video podcast on art forgery or misattribution at: www.acs.org/chemmatters

SELECTED REFERENCES

Salisbury, L.; Sujo, A. *Provenance: How a Con Man and a Forger Rewrote the History of Modern Art*. Penguin Press: New York, 2009.

Akbar, A. We Bought Forgeries, Says National Gallery. *The Independent*: http://www.independent.co.uk/arts-entertainment/art/news/we-bought-forgeries-says-national-gallery-1946468.html [accessed Nov 2010].

Thompson, C. How to Make a Fake. *New York Magazine*: http://nymag.com/nymetro/arts/features/9179/ [accessed Nov 2010].

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