How to Clean Your Optics

All reflective optics eventually need cleaning. Here's how to safely do the job.

After cleaning with distilled water and mild soap, the mirror should be left to dry resting on its edge so that the remaining water runs off its surface.

It's a well-known fact that if your desire is to resolve tiny details in anything in the night sky from albedo features on Mars to star-forming regions in distant galaxies, you need a good-sized primary mirror. For visual observers, that typically means a large reflector, typically a truss-tube Dobsonian. Astrophotographers might follow the lead of professional observatories and opt for a large Cassegrain instead.

The drawback of any reflector is that its optics are exposed to the environment, and inevitably accumulate dust, soot, and other potentially harmful contaminants. Eventually, you will have to clean your scope's optics to maintain its performance. But removing dirt from an aluminum coating is a delicate matter.

Today, there are several commonly used methods for cleaning reflective optics. I've cleaned numerous mirrors myself using a variety of techniques up to and including the CO_2 gas method often used by professionals. Each is helpful, though some are more effective than others depending on your particular optics and observing environment. Let's review your options.

To Clean or Not

The biggest decision when caring for your optics is determining whether they actually need to be cleaned at all — it's best to err on the side of caution. Mirror coatings are fairly delicate (particularly those without an additional, protective layer), and it only takes one overzealous cleaning to scratch through the coatings and even gouge the glass itself.

Dust and smudges on your optics are bad because they absorb and scatter light, which reduces contrast, sharpness, and dims the view. But how long can you go before your mirrors need a good bath? While a little dust isn't usually a problem (it doesn't absorb much light), other contaminants, particularly pollen and ash from wildfires, form aggressive organic

▶ **CAREFUL DABBING** The most common mirror-cleaning technique for small to mid-sized mirrors is to lightly dab the surface with soaked cotton balls.

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compounds with moisture that can create discolored spots on mirror coatings, eventually destroying the reflectivity.

When assessing your optics to determine if they need attention, understand that coatings almost always look dirty when viewed from the side or when illuminated by a bright lamp. It's the vertical incidence of light striking the mirror straight on that's most important, so if dust and other contaminants become noticeable with a casual glance, it's probably time for a cleaning.

Dabbing with Cotton

The most common cleaning technique employed by amateurs is to use cotton balls soaked in distilled water. A wet cotton pad can remove dirt from the mirror after it's been generously rinsed. Use circular movements but with a minimal amount of pressure. In my experience, wiping with cotton seems to be quite effective. However, the aluminum layer can be microscopically scratched by the particles adhering to the cotton as it moves across the mirror surface.

Alternatively, you can simply dab at adhering particles with moistened medical absorbent cotton to loosen and remove dirt. However, the effectiveness of this method is limited to particles that loosely cling to the mirror. After dabbing, some cotton residue may remain on the mirror's surface. To remove this, let it dry and gently sweep these areas with an optical cloth. I used to use this method for cleaning small optics. (See page 36 in the March 2019 issue for a detailed description of this process.) These days, I feel that it should only be used when the mirror is completely immersed in a water bath or has a constant flow of water across its surface.

Immersion Washing

Another efficient cleaning method is to wash the mirror while it's fully immersed in water. Using this routine, we were able make the 80-centimeter (31.5-inch) primary mirror at Waldbröl Observatory relatively clean. We first soaked it for several hours in water with a few drops of a cleaning liquid (typically Ivory or Dawn dishwashing soap) and then sprayed it with a jet of water. While the mirror is still under water, you can try to remove any remaining dirt by dabbing cotton on problem areas, but be sure to avoid wiping the cotton over the mirror to avoid creating fine scratches called sleeks. Finally, rinse the mirror with distilled water and place it upright on a soft towel so that the water can run off. This routine also worked well for a 12½-inch mirror I cleaned a few years ago.

Larger optics can also benefit from the immersion-cleaning procedure. For example, the telescope technicians wash the 2-meter mirror at the Wendelstein Observatory in the Bavarian Alps in Germany annually using a two-stage process. They begin by removing the mirror and soaking it in distilled water with a soap solution then adding diluted isopropyl alcohol.

The 1.12-meter mirror at the Expo Observatory in Melle, Germany, on the other hand, must be cleaned while installed, though it's still possible to fully immerse its coatings. They simply pour water onto the primary with the telescope aimed exactly at the zenith, and the shallow curve of the mirror acts like a very shallow bowl. After soaking, they dab a cotton swab over the mirror surface before draining the liquid. The scope is then tipped to pour out the water and mopped up.

Whether either washing method is suitable for your telescope depends on your situation. A big advantage of the

▲ **BATH TIME** *Top:* Eventually, every telescope with reflective optics needs cleaning. The best approach depends on several factors including the mirror's size, weight, whether it has a protective overcoat, and what type of contaminants are present. This image shows the 0.8-meter primary mirror of the Waldbröl Observatory in Waldbröl-Schnörringen, Germany, awaiting cleaning.

▲ **A THOROUGH RINSE** *Bottom:* Following a period of soaking in warm, soapy water, the primary mirror is sprayed down to remove as much loose dust as possible before drying.

latter is that the mirror doesn't require removal — which is extremely desirable for large, heavy mirrors. Unfortunately, this process only works with Newtonian reflectors that don't have a central hole like those found in Cassegrains. For perforated mirrors, you'll need to take extra measures to prevent water from draining though the central hole.

Dusting and Gas

In principle, dusting with pure-cotton optical cloths is a very effective way to remove loose contaminants and can lengthen the life of your mirror's coatings. At the Karl Schwarzschild Observatory in Tautenburg, Germany, the 2-meter primary mirror is lightly brushed with optical cloths every 14 days. This roughly doubles the service life of the mirror, extending the period between recoating to between 6 to 8 years.

While this technique is easy to perform, it requires careful attention. A new piece of fabric is used for each dusting pass, and washed cloths are only usable after laundering with liquid detergent in a washing machine exclusively used for optical cloths. However, much like dabbing with absorbent cotton, this approach won't remove sticky dirt.

Using carbon dioxide (CO_2) gas is a well-established optics-cleaning technique among professionals.

A spray nozzle with an adjustable valve is connected to a gas cylinder containing liquid CO_2, which is blown over the mirror. As it's released from the cylinder, the liquid instantly expands into a gaseous state, and cools adiabatically to become a blast of CO_2 snow. These frigid snowflakes then collide with the dust particles, making them contract abruptly due to the sudden temperature drop and causing them to detach from the mirror's surface. The gentle pressure of the CO_2 snow then pushes the particles off the coating without having to physically touch the optical surface. The CO_2 flakes and dust don't scratch the mirror coating because they glide over the surface on a gas cushion that sublimates from the snowflakes. The method is easy to do and gentle enough to be performed repeatedly until the mirror requires a new coating, which is why it's used at professional observatories.

Yet, CO_2 cleaning isn't always the best approach, depending on conditions at the telescope's location. Professional observatories are usually located at relatively dry sites at high elevations and in deserts, where the main contaminant is

▼ **FRIGID BLAST** A telescope technician at the Very Large Telescope at Paranal Observatory in Chile sprays the 8.2-meter primary mirror of the UT1 telescope (Antu) with carbon dioxide (CO_2) gas.

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▲ **STEAM TREATMENT** A new alternative to CO_2 gas cleaning, technicians at the Isaac Newton Group of Telescopes use steam to remove contaminants from the William Herschel Telescope's 4.2-meter mirror.

▼ **A GOOD DUSTING** *Left:* Telescope mirrors located in dry environments can be kept clean with regular, gentle dusting using optical-quality cloths. A technician dusts the 2-meter primary mirror at the Karl Schwarzschild Observatory with a cotton cloth.

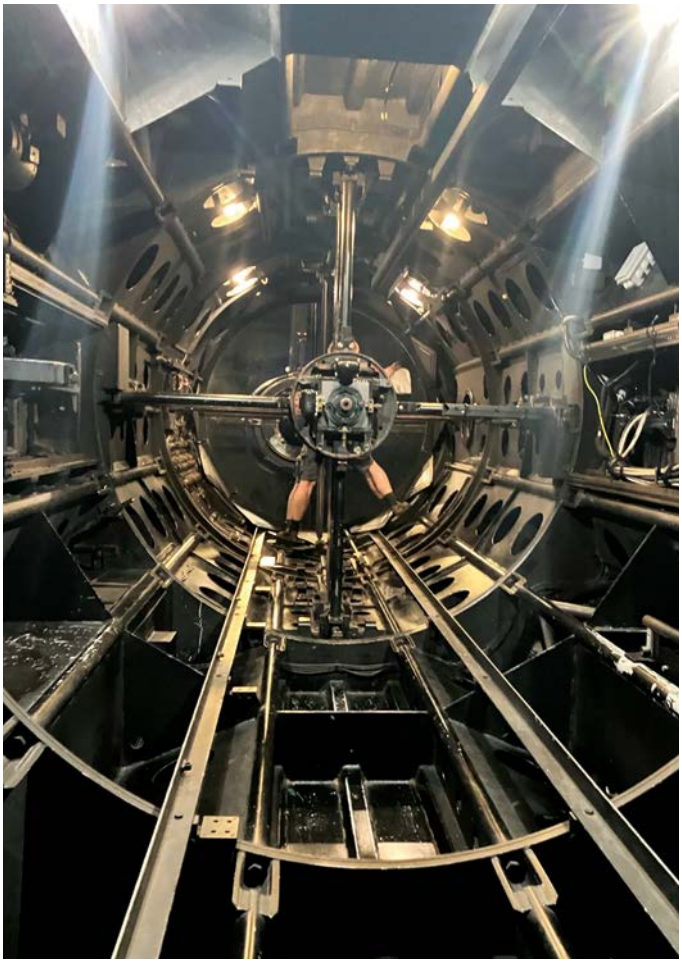
▼ **A COMBINING APPROACHES** *Right:* Waldbröl Observatory's 0.8-meter primary mirror undergoes steam cleaning and careful dabbing with cotton before a final rinse.

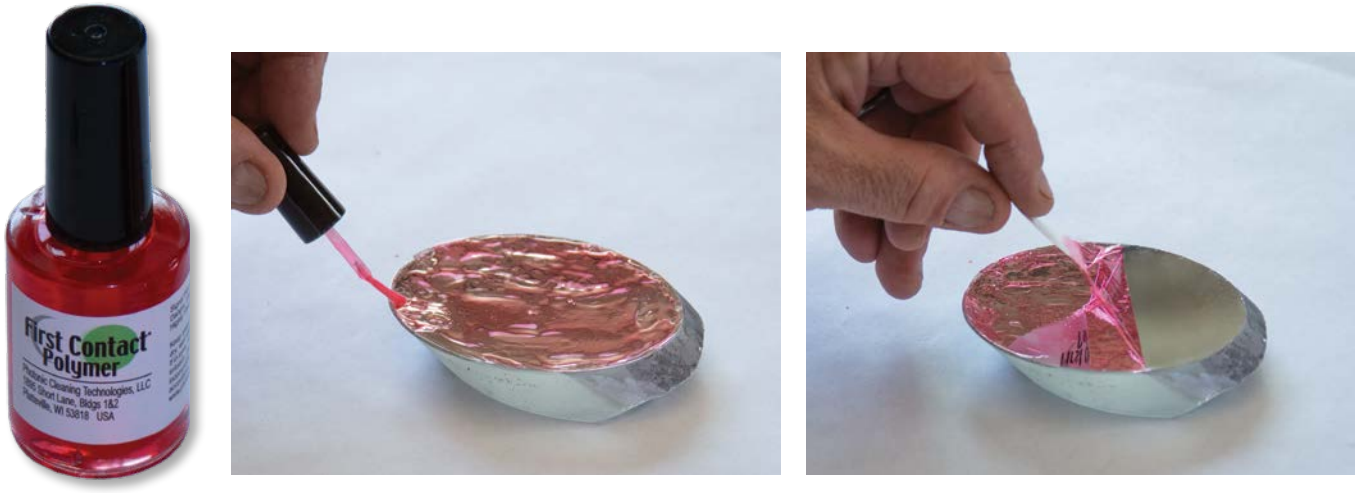
dust with little or no humidity. The situation is usually different for your telescope.

Most amateur telescopes reside in typically more humid environments such as the owner's home or backyard observatory, and the scope travels to dark-sky locations. The optics not only get their fair share of settling dust, pollen, and other contaminants, but the stuff is stuck onto the surface due to the effects of humidity. When this happens, a CO_2 blast isn't effective.

A study at the Isaac Newton Group of Telescopes at the La Palma Observatory in the Canary Islands estimates the improvement in reflectivity at around 2% after a CO_2 cleaning, while telescope technicians at the McDonald Observatory in Texas note the 11-meter Hobby-Eberly Telescope experiences "considerable improvement" in reflectivity following a CO_2 treatment. Because large professional reflectors require recoating on a regular basis, it's safe to assume that the soiling of the mirror is only slowed down with regular cleaning rather than arrested completely.

Another impediment to this technique is that CO_2 mirror-cleaning equipment is rather expensive — in the range of $3,000. That doesn't make it very attractive for home use. On online forums, some amateurs have suggested utilizing CO_2 fire extinguishers to clean mirrors. However, this





▲ **CHEMICAL PEEL** *Left:* A very effective mirror-cleaning method is to apply a quick-drying polymer, such as collodion or other specialized products like First Contact Polymer designed specifically for telescope coatings. *Middle:* The liquid polymer is brushed or sprayed on to the mirror's surface in a well-ventilated area. *Right:* in a few minutes, the polymer dries and is removed with tape for a result that's often better than with other methods.

is risky because there's no guarantee that the gas in such extinguishers is clean and free of unwanted particles. Last but not least, it's very important to note that CO_2 cleaning can only be performed in well-ventilated areas due to the very real risk of suffocation!

Steam Cleaning

Another spray-cleaning method has gained traction in professional observatories in recent years. Technicians at La Palma have begun treating the optics with steam, which produces an opposite temperature effect to the cold CO_2 treatment.

This approach begins with moistening the mirror with soapy steam. The soap vapor, heated to 35°C, removes large dust particles. Like the temperature shock with CO_2, the warm steam meeting the colder mirror loosens most particles. Before the mirror is dried, the soap is removed from the surface with steam created from distilled water (as steam can carry particles with it). Finally, to achieve the same results as washing, the optics are dabbed with natural sponge or swabs.

Compared to simple washing, the water-vapor method uses significantly less water and is easily controlled with towels. The results are comparable with conventional washing, but without having to remove the mirror. The observatory uses industrial steam cleaners, but you can use household steam cleaners. Technicians found that it takes a lot of effort to damage the coatings with this technique — they applied the steam stream continuously a few centimeters away from the optical surface for 20 minutes, causing the mirror coating to slightly deteriorate. According to their analysis, steam provides a better result than $C0_2$ cleaning and has become the method of choice for the 2.5-meter Isaac Newton Telescope and the 4.2-meter William Herschel Telescope.

Polymer Peel

Another cleaning method utilizes a mixture of various chemically inactive polymers or liquid plastics such as collodion. In contrast to the methods described above, the liquid polymer is applied directly to the mirror surface, where it then hardens when the solvent evaporates and forms a flexible film. This film is then peeled from the mirror along with the accumulated dust. Collodion is highly flammable and contains the chemical compound ether, so it should be used in a well-ventilated area. A similar, less hazardous polymer called First Contact is available from Photonic Cleaning Technologies (**photoniccleaning.com**). It was developed specifically for cleaning telescope optics.

On the one hand, the material is ideal for removing adhering particles. On the other hand, it can also remove mirror coatings that have poor adhesion qualities, resulting in the need for a complete recoating. The manufacturer recommends testing the polymer on an unused section of the mirror — an area covered by retaining clips or in the shadow of the secondary mirror.

Unlike CO_2, the polymer film also dissolves grease and other materials glued to the coatings by humidity. Incidentally, the polymer also protects the optics against dirt and damage during transportation, so you could apply it before taking your scope to a dark-sky site and then peel it off before observing.

The Choice Is Yours

Ultimately, there is no ideal way to clean mirrors. The best method depends on the type and degree of soiling, and what kind of telescope you have. Each method presented here is meant to maximize the reflectivity and extend the life of your mirror's coatings. Regular maintenance slows the accumulation of particulates on the mirror surface. Find the cleaning technique you're most comfortable with and keep your optics in their best condition.

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