Photographing Snowflakes

Michael Peres

Photographing snowflakes has become an important winter activity that began at the suggestion of one of my former students more than a decade ago. Rochester, New York can expect to receive an annual snowfall of more than 100 inches. Each season I look forward to the challenges and adventures of this outdoor activity. Experience is a good teacher and over the years I have developed some basic methods for photographing snowflakes that relies on common equipment and some practical methods when working outside in the cold.

I should add that all snow is not well suited for photographing. While not a meteorologist, I have come to appreciate when conditions might be right for good ice crystals. Often the snow looks like table salt and has no aesthetic qualities or it might look like ice needles. Many factors affect the formation of a "pretty" snowflake and the occurrence of great flakes is actually a rather random event during our long winter season. Whenever I am out and about I am always on the look out for the appearance of good snowflakes and I hope I am near my microscope when the ideal conditions present themselves. In this article, I will share my basic methods and thoughts on how to make photomicrographs of this interesting subject matter.

Photographing snowflakes must be accomplished at temperatures that are below freezing and needs to be performed outdoors or in unheated structures. There are several contemporary scientists that make snowflakes in their laboratories but this article will focus on the process of catching and photographing naturally occurring snowflakes. To photograph snowflakes, all equipment must also be kept below freezing; which is necessary to preserve the ice crystal as long as possible. It seems the best snowflakes come when the air temperatures are between 15 and 20 degrees Fahrenheit. To make my photomicrographs I place the snowflakes on pre-cleaned microscope glass slides for ease in handling which reveals their delicate crystalline structures. Simply holding the glass slide in a bare hand will begin to warm the slide and melt the flake. Because light is radiated energy, the simple process of shining a light on the flake will cause it to begin to warm. Pristine snowflakes have a short life cycle and wearing gloves will minimize heat transfer and postpone the inevitable melting.

When at home, I work in my garage. I have found that when photographing, the outside temperatures must be below 30°F at an absolute minimum. My garage is attached to the house and there is a microclimate within the garage. I keep the garage door open for some time to acclimatize the equipment to the cold, which generally takes more than 30 minutes. For that reason I leave my equipment out in the garage and the cold all the time. Because the garage is used for cars as well, there is also a lot of humidity. To minimize exposure to excess moisture, I take the optical parts from the instrument into the house when possible. Isolation from wind and falling snow is also important. A garden shed or a tent might serve as a good space if large enough. Staying warm is also important: I use a piece of foam insulation on the floor to help create an additional weather barrier to the cold conditions. Because there is little movement necessary in accomplishing this work, you will get cold quickly once the adrenaline subsides.

The best way to catch and identify good snowflakes for photographing is to use a piece of black velvet as a catching tray. I place the velvet in a small old metal baking pan but truly anything that is stiff will work. Black velvet is ideal because it allows for easy identification as a result of the increased visibility it creates but it also provides a good surface for the easy lifting of flakes using a sewing needle taped to a pencil. Velvet allows a needle to pass through fibers without dragging. Other fabrics have a nap and "hang" onto the flake resulting in breakage and frustration. Using a needle, it is best to carefully pick up the very small delicate ice crystals and transfer them to 3" x 1" glass slides. I have come to believe that there is also a static attraction between the flake and the needle. Efficiency is important and having good hand-eye coordination is critical. You should be advised not to breathe heavily onto the slide once the snowflake has been transferred because you may accidently blow it away or worse yet, melt it. I truly hold my breathe during numerous phases of the work.

Snowflakes will come in many sizes, shapes and conditions. On average 1-2mm flakes are ideal based on my experiences and my imaging system. I find that working in the 2-8x magnification range is just about right for my equipment. It should be noted though, it is good practice to immediately photograph what you get as the flakes can be huge or mere platelets (embryonic flakes). Achieving this magnification range can be readily accomplished using many types of equipment and methods. I have tried many instruments including a compound microscope, macro lenses on a bellows and a stereomicroscope. Recently I built a simple, homemade microscope using parts from broken vintage instruments including the base of a Nikon Multi-Photo and a focusing stage from a 1930s Bausch and Lomb Bench L. This instrument has proven to be very easy to use for accomplishing

Snowflakes have a variety of facets and characteristics that require alternative approaches to lighting. I often interject my finger into the light path to create oblique angle lighting or I place a large coin on the collecting lens above the field stop.

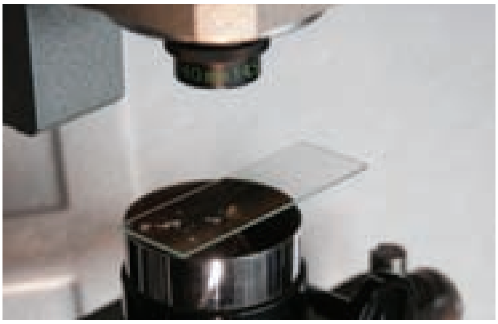
the things I expect in this work. Instrument stability is imperative and the big heavy base has served my imaging outcome well.

Almost any compound microscope would be an effective tool for this work because it comes with a built-in illuminator and can achieve a variety of magnifications. It should be equipped with low magnification objectives such as 2X and 4X to photograph snowflakes. Optically these magnifications are produced from objectives with low numerical apertures and hence the resultant images might not be as resolved as one might like. I would also suggest a low magnification photo eyepiece such as a 1.3 – 2.5x. The magnification produced with a compound instrument will be sometimes too high for photographing entire flakes even with the above listed components. This aspect of the imaging outcome is also affected by the DSLR's sensor size. Full size sensors have advantages in this realm of imaging but are more expensive. Traditional use of the instrument's diaphragms and field stop will not be employed in the same ways as when producing Kohler Brightfield illumination. Snowflakes have a variety of facets and characteristics that require alternative approaches to lighting. I often interject my finger into the light path to create oblique angle lighting or I place a large

For my snowflake photography, I often use a fiber optic illuminator that has 2 light guides.

coin on the collecting lens above the field stop. It might also be useful to remove the sub-stage condenser for alternative lighting outcomes. I also employ optical staining of certain snowflake characteristics using plastic bags or other coloured elements. I often also create top light with a fibre optic illuminator and use the built in illuminator as well.

Another effective method to achieving magnification in this range is to use a simple microscope. This would be defined as a macro lens attached to a bellows or extension tube. An example would be found in the use of a 60mm macro lens with approximately 8 inches of bellows to produce this magnification. $V = (m+1)\ f$. Shorter focal lenses will create higher magnifications using less bellows length. Each element – bellows length or focal length - has its advantages. Longer focal length lenses provide more working distances while shorter focal length lenses will use less bellows. A lens that I personally have not used but would like to try is the Canon Macro MP-E 65mm f/2.8 lens. This lens can achieve magnifications up to a 5X without accessories and couples directly to the Canon camera body. This would seem ideal to me but I have no immediate experience in how it would perform in actual use for this application.



Stereomicroscopes can be an easy instrument to use for this type of photography but it also has some elements that create unique challenges for users. One large challenge when using a stereomicroscope is the need to create a platform to hold the glass slide where the flake has been placed. Simply locating the slide on the base of the instrument will lead to less than satisfactory results. One trick I have used to resolve this problem is to tape the slide onto the lens cap, which is still attached to the lens. The lens can be rotated and behave much like a lab jack. By elevating the slide from the base, interesting and angular lighting using fibre optics can easily be used to supplement any illumination produced by the instrument's built in illumination if present. Depending on the primary objective's magnification, stereomicroscopes can have a magnification range of 2.5X-25X on the low side and up to 8X – 80X when using a higher magnification objective.

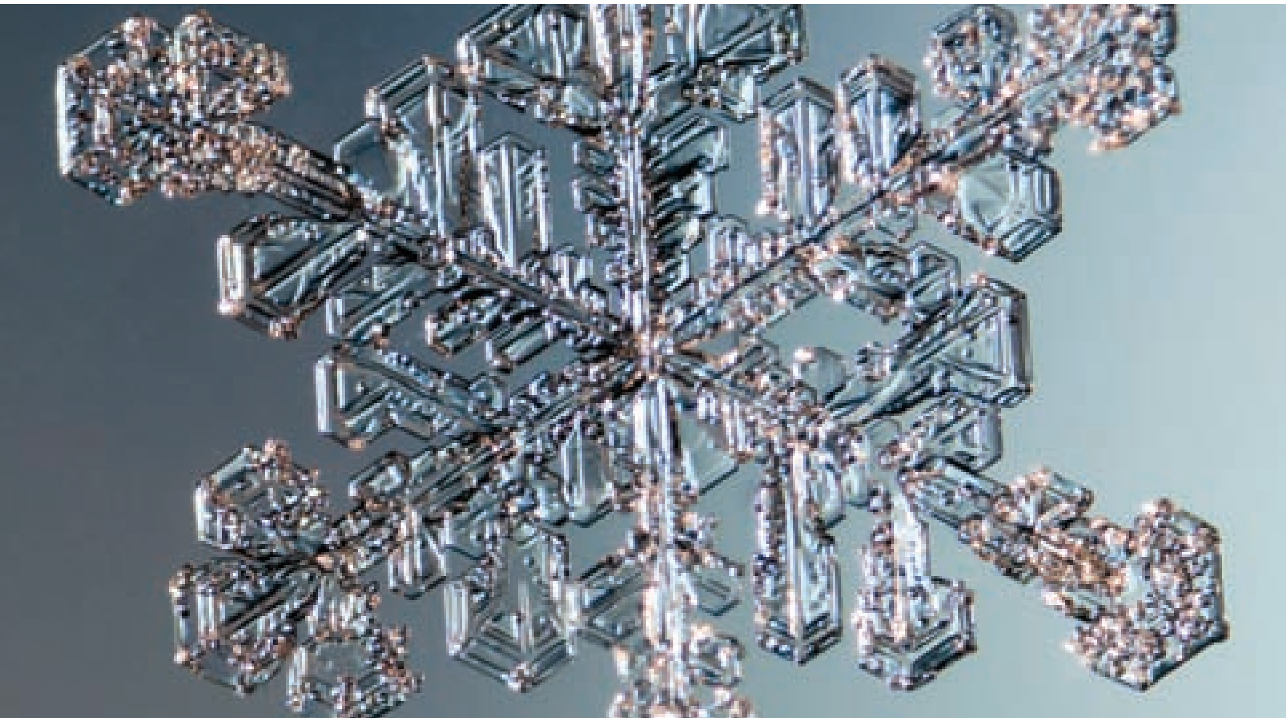
Making photomicrographs in this magnification range has some interesting challenges. Typically objectives that might be used for this magnification have infinitely low optical performances and create a wide range of Depth of Field (relatively speaking). For this reason achieving critical focus can be tough, as everything in the viewfinder appears to be of the same sharpness. This focusing challenge is often compounded when using a Digital Single-Lens Reflex camera with a Fresnel type viewfinder screen. The topography of the focusing screen is actually coarser than the image detail and so critical sharpness is not possible. To manage this challenge I always focus using the coarse focusing knob and go past the focus and bring it back. I also try to focus quickly. I have been known to hold my breath for this since, blood pressure in the retina can change the critical vision needed to see distinct and small structures.

While there is no easy way to couple a compact digital camera to a microscope, it is possible to make photomicrographs using one. When using a cell phone or compact digital camera, it is possible place the camera's lens at the photo ocular lens' eye

I have this conflict of love and hate. I am always amazed by what I can see using the microscope and in my brief time working in this realm of photography, I have not found two flakes to be identical.

point. When this is accomplished, the camera's lens will relay the image from the microscope effectively to the sensor without degradation. I suggest setting the camera to its longest focal length setting when using this technique. Handholding the camera will be very difficult if not impossible. It should be stated alignment of the camera is critical. Most of the time, I use a tabletop or vertical camera stand and I suspend the camera over the photo eyepiece. If you do not have a vertical stand, you can use a tripod and locate the microscope on the ground. If you are fortunate enough to be using a photomicroscope, the camera system may already be integrated. If not, I would suggest using a DSLR and suspend the camera over the eye point using the above-mentioned method. When using a DSLR, you should remove the camera lens. One only needs the camera and sensor for this work. Locate the camera at the distance where the microscope's circle of good definition is large enough to cover the sensor. By using black construction paper or a similar type of rigid black material, you can create a tube to act as a light baffle around the microscope's photography tube. This baffle should be long enough to reach the camera body but not enter the camera itself. This baffle will block extraneous light from being imaged, which will degrade contrast. Care should be taken with any camera type to ensure the camera's sensor is perpendicular to the optical axis. If the camera is not oriented properly, focus will be lost across the field of view. It is important to trigger the camera using the camera's self-timer. Trying to operate the camera when cold will cause image vibration.

Lighting is a critical component of all interesting photographs. For my snowflake photography, I often use a fiber optic illuminator that has 2 light guides. This light may be used to supplement the microscope's built-in illuminator. I often use both top light and bottom light. This leads to images with interesting internal reflections and reveals surface texture. The snowflake's structure is much like a



diamond with its many facets and I have found that when using episcopic and diascopic illumination I can emphasize the facets and numerous angled surfaces these miniature structures contain. Producing light that creates internal reflections is my ultimate goal. I have used colour gels, colour backgrounds as well as monochromatic strategies during my numerous explorations. One of the things I enjoy the most in my work is to simply fool around with the light and see what happens I also using a darkfield stop on the field stop to create modified darkfield. In the end, all experiments with illumination should lead to more contrast and subsequently more visibility.

While I attempt to be clinical and sterile in my slide preparations, invariably numerous artifacts become part of my preps. I have coined an expression in my classroom that suggests students will photograph more dirt than objects and in my garage laboratory this could not be truer. My workflow is rather simple. I shoot RAW file format using a professional DSLR camera. I use ISO 200 and a colour space of Adobe RGB. My sensor is 4000 x 3000 and provides high digital resolution. Once I have identified which photomicrographs are interesting, I use Adobe Photoshop to process these files. Initially I pre-process the files in a RAW file converter. I improve various capture features including tone changes, black and white point settings as well as overall

image sharpness. Once this pre-processing has been completed, the file is opened and more robust image processing can be undertaken.

During this phase of my image processing, I remove the majority of artifacts that have found their way into my preparations. This might include streaks of moisture, the by-product of cleaning the slides from re-use, and dirt and fibers that somehow always find their way into the system. No matter how hard I try, I am cursed with this problem. Slides can easily be re-used but will experience the above-mentioned problems more frequently. It can be slow work to remove. Because of the simplicity of the images I produce and their isolation, artifacts will compete visually with the flakes.

Once I am satisfied with the tone and related image characteristics that I have produced, I sharpen the file. This is the last step in my workflow. I find sharpening using a high band pass filter is optimal. This is accomplished using PhotoShop by copying the file as a new layer and then in filters, selecting the high band pass filter. I determine the proper degree of sharpening by observing when the image outline or threshold becomes visible in the preview window. Once satisfied that I have achieved this condition, I blend the layers using overlay. It is easy to over sharpen and I am careful not go to this

place. Having someone share they love your image processing skills is by no means a compliment and suggests it is noticeable. It is most important that the image is the focal point and not the image processing.

I look forward to the first coming of snowflakes each year. Finding and photographing them can be intoxicating until you are numb with cold. It can be hard to stop when a good band presents itself. As the season progresses, my passion persists but I hate winter. It is such a long season. It is grey and everything about it makes things more difficult. I have this conflict of love and hate. I am always amazed by what I can see using the microscope and in my brief time working in this realm of photography, I have not found two flakes to be identical.