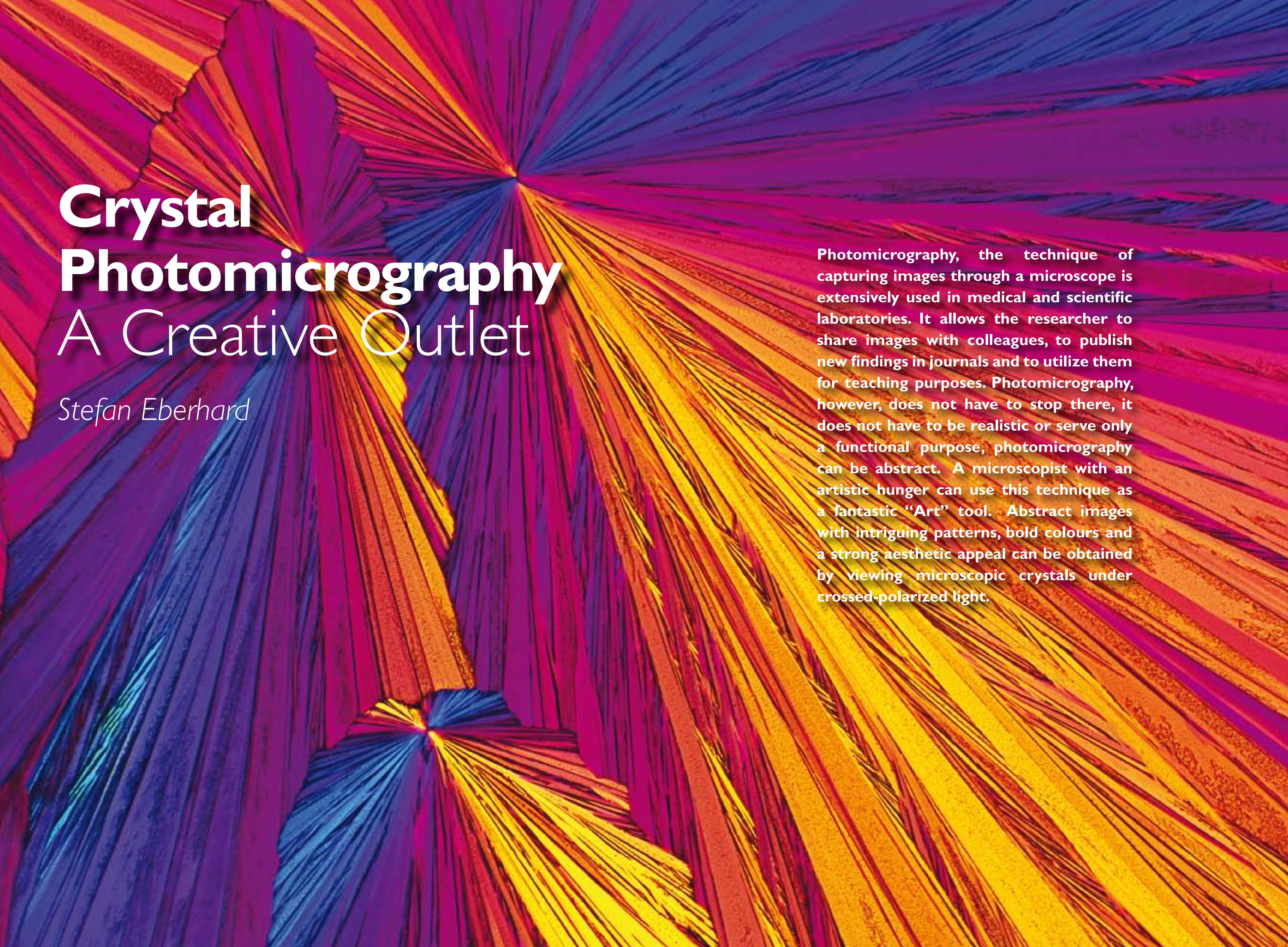

Crystal Photomicrography
A Creative Outlet

Stefan Eberhard

Photomicrography, the technique of capturing images through a microscope is extensively used in medical and scientific laboratories. It allows the researcher to share images with colleagues, to publish new findings in journals and to utilize them for teaching purposes. Photomicrography, however, does not have to stop there, it does not have to be realistic or serve only a functional purpose, photomicrography can be abstract. A microscopist with an artistic hunger can use this technique as a fantastic "Art" tool. Abstract images with intriguing patterns, bold colours and a strong aesthetic appeal can be obtained by viewing microscopic crystals under crossed-polarized light.

The modern microscope is an important and indispensable tool in science and medicine. It is an extension of the human eye that permits us to look at things that lie beneath the threshold of normal perception. Only with the help of a microscope can we dive into the microworld and start to explore it. For example in the ever-growing field of neuroscience it is a crucial instrument that allows neuroscientists to study brain cells affected by neurodegenerative disorders, such as Alzheimer's and Parkinson's diseases. In numerous industrial settings the microscope also holds a vital place as an inspection tool for quality control, such as in the manufacturing of circuit boards.

The microscope, however, is not only found on a research scientist's bench, it can also be found virtually in any line of work such as medicine, biology, geology, the food industry, criminology, forensic medicine and in very common places like the local jeweller and optician and, of course, in schools where it serves as an important educational tool in science classes.

Very often it is necessary to capture an image that is seen through a microscope. By combining photography and microscopy we are able to capture the images of the microworld. A photograph that is made through a microscope is called a photomicrograph. Photomicrographs are used by research scientists to share their findings through publication in periodicals, books and online and are also widely used as teaching aids in the classroom of high schools and universities.

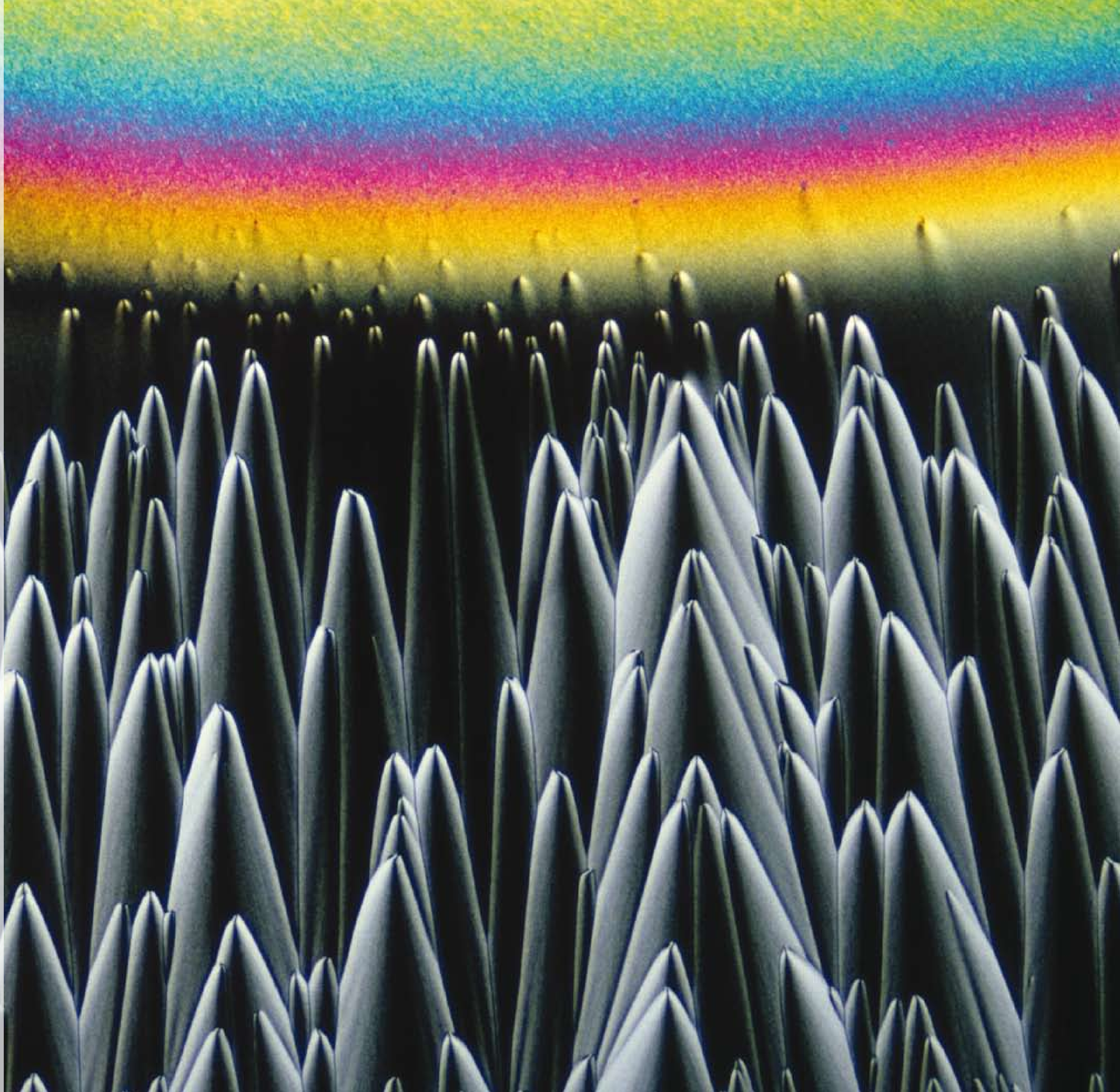

Fig. 1. Image 01 - Ascorbic acid (Vitamin C). Magnification 15X. Field of view = 1.5mm.

Fig. 2. Ascorbic acid (Vitamin C). Magnification 15X. Field of view = 1.5mm.

Although photomicrography is mainly used for documentation in science and industry, it can also be an art form. A microscopist with an eye for colour, design, and composition can employ the microscope as an art tool.

For many years I have used photomicrography purely for documenting my research efforts and for functional purposes. In the late 1980's I came across an article about polarized light microscopy that included colourful and abstract images of crystallized Vitamin C. As an amateur photographer, I was intrigued by those stunning images because I have always enjoyed photographs or paintings with bold colours and abstract shapes. A canvas and a brush in my own hands never transpired to anything fruitful though. Then a thought went through my head - maybe the microscope can fill this void!

So, I did some research on how these photomicrographs were created and I learned that many crystalline substances are birefringent; they can split or refract light into two separate rays travelling at different velocities, also called double refraction. This phenomenon is seen in many anisotropic crystals. When a birefringent material is placed between a pair of crossed polarizing filters (one between the light source and the specimen, the other between the specimen and the camera) the otherwise colourless material becomes visible by means of interference colours. An excellent and more in depth look at polarization can be found at: www.microscopyu.com/articles/polarized/polarizedintro.html.

With this knowledge I started to experiment on my own by growing crystals from a variety of chemicals such as vitamins, fertilizers, artificial sweeteners and many other crystalline substances. I was taken by the striking colours and abstract forms that the micro-crystals revealed by viewing them in polarized light. Capturing the images by photomicrography opened up a whole new world to me for self-expression and for expanding my creativity.

Micro-crystals can be obtained by dissolving a small amount of a chemical in water or in another solvent like alcohol, and by placing a drop of the solution on a microscope slide. Crystals will soon form as the solution evaporates. Another technique for producing stunning crystal formation is to make a "melt" by carefully heating a small amount of a chemical that is sandwiched between a microscope slide and a coverslip until the chemical melts. By removing the heat, micro-crystals will begin to grow as the chemical cools down. Different patterns of the crystals can be obtained by varying the temperature or the humidity during the recrystalization process. I often let a "melt"- preparation cool down very slowly to give the crystals more time to grow. Occasionally none of these techniques gives me the crystal formation I was hoping for, such as with fertilizer. In such cases the procedure needs to be slightly modified. I successfully grew crystals of water-soluble-fertilizer by sandwiching a drop of a concentrated aqueous solution between a microscope slide and a cover slip and subsequently sealing it with mounting medium to prevent evaporation. No heat is applied in this process, but you need a dose of patience because it can take days or weeks for the crystals to show up.

Fig. 3. Niacinamide (a water-soluble B-complex vitamin).
Magnification 15X. Field of view = 1.5mm.

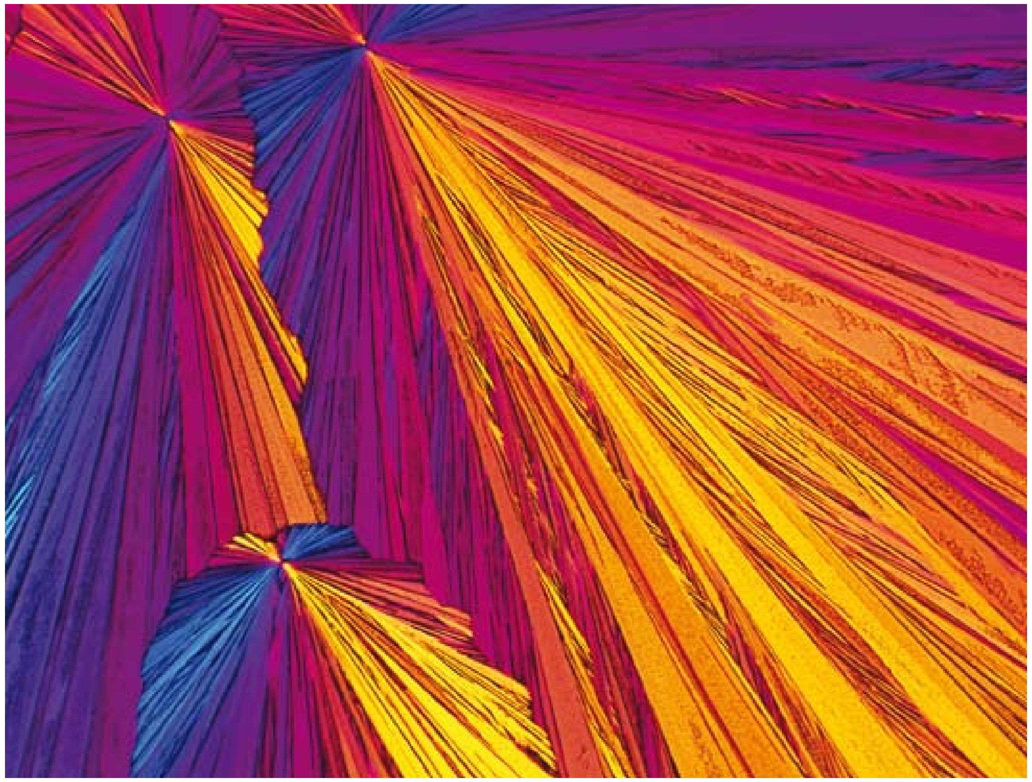

Fig.4. L-Cystein (an amino acid). Magnification 15X. Field of view = 1.5mm.

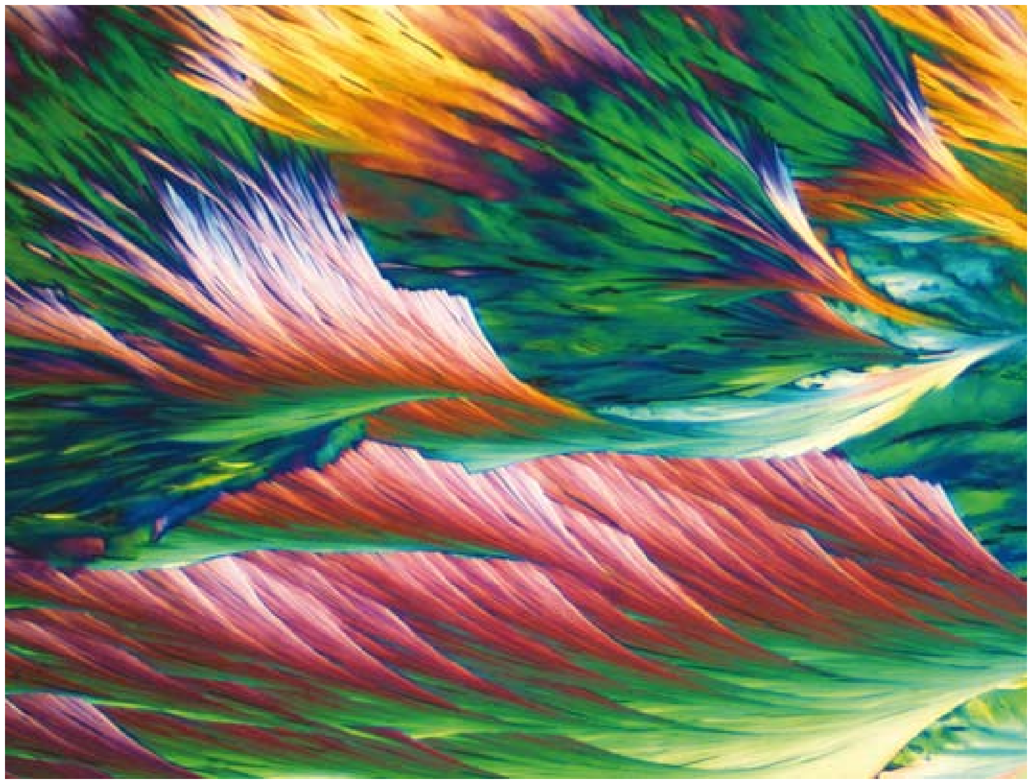

Fig.5. Palmitic acid (a saturated fatty acid). Magnification 15X. Field of view = 1.5mm.

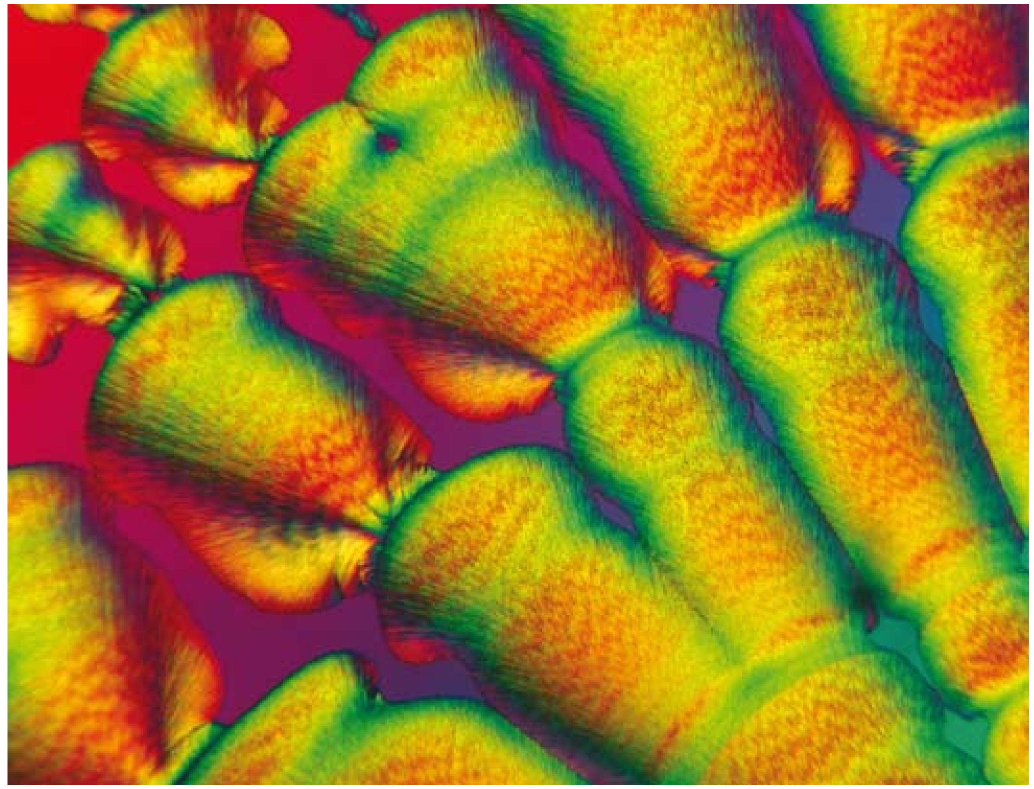

Fig.6. Glucose. Magnification 15X. Field of view = 1.5mm.

Fig.7. Folic acid (Vitamin B9). Magnification 15X. Field of view = 1.5mm.

Every time crystals are grown on a microscope slide the results are unpredictable. You never get the same crystallization twice, so if the patterns are not as you like, the crystals can be simply dissolved or heated again.

Photomicrography is an example where the two disciplines of art and science can come together in a symbiotic relationship. I use the science to help me create images to express myself artistically; I don't give a particular scientific value to my images. For me, the photomicrography of crystals is an outlet to create abstract images with aesthetic appeal.

As demonstrated with these images, the microscope serves as the gateway to a colourful and hidden microworld. Exploring and capturing the microworld seems infinite, the only limitation is your own creativity.

Fig. 8. Folic acid (a B vitamin). Magnification 15X. Field of view = 1.5mm.

Fig. 9. Saccharin (artificial sweetener). Magnification 15X. Field of view = 1.5mm.

Fig. 10. Fertilizer. Magnification 15X. Field of view = 1.5mm.

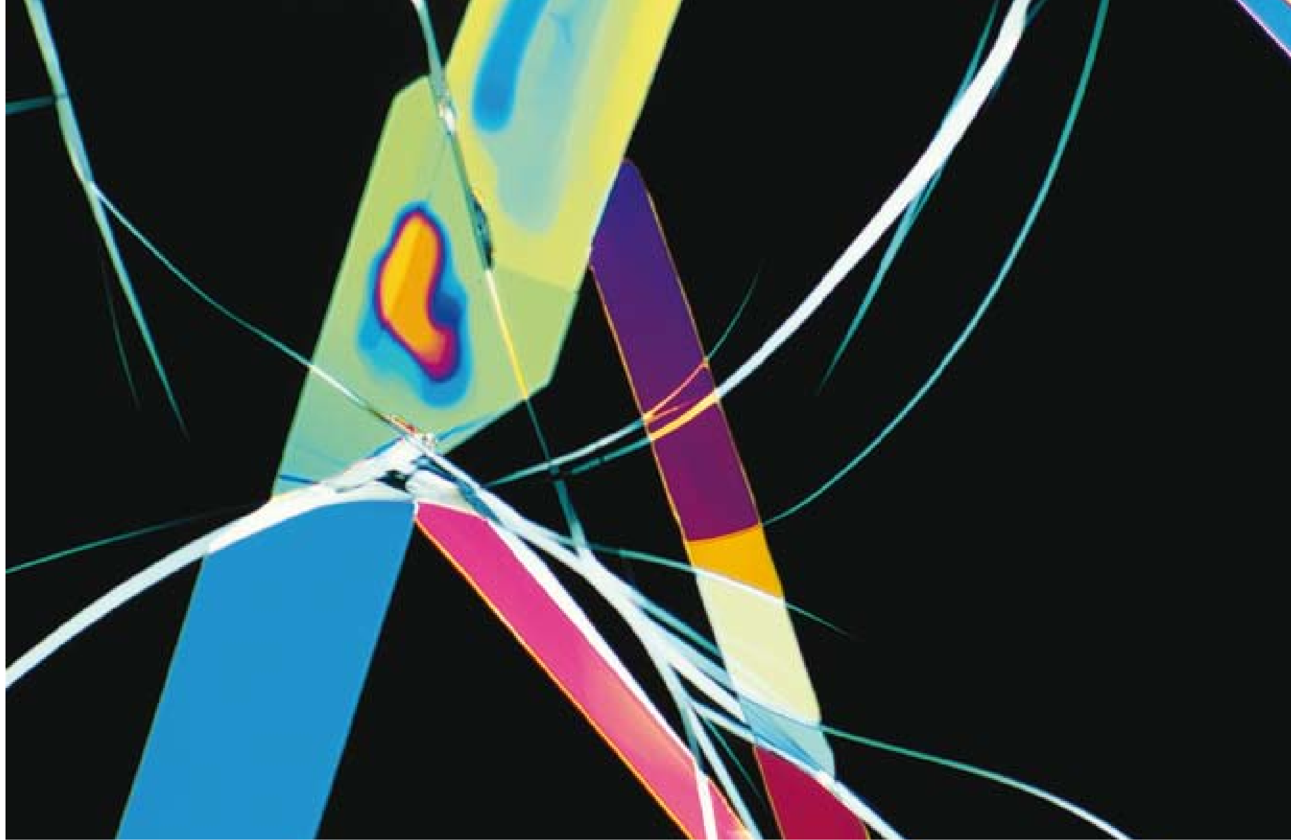

Fig. 11. Fertilizer. Magnification 15X. Field of view = 1.5mm.

Fig. 12. Cyanocobalamin (Vitamin B12). Magnification 15X. Field of view = 1.5mm.

Fig. 13. Ascorbic acid (Vitamin C). Magnification 15X. Field of view = 1.5mm.

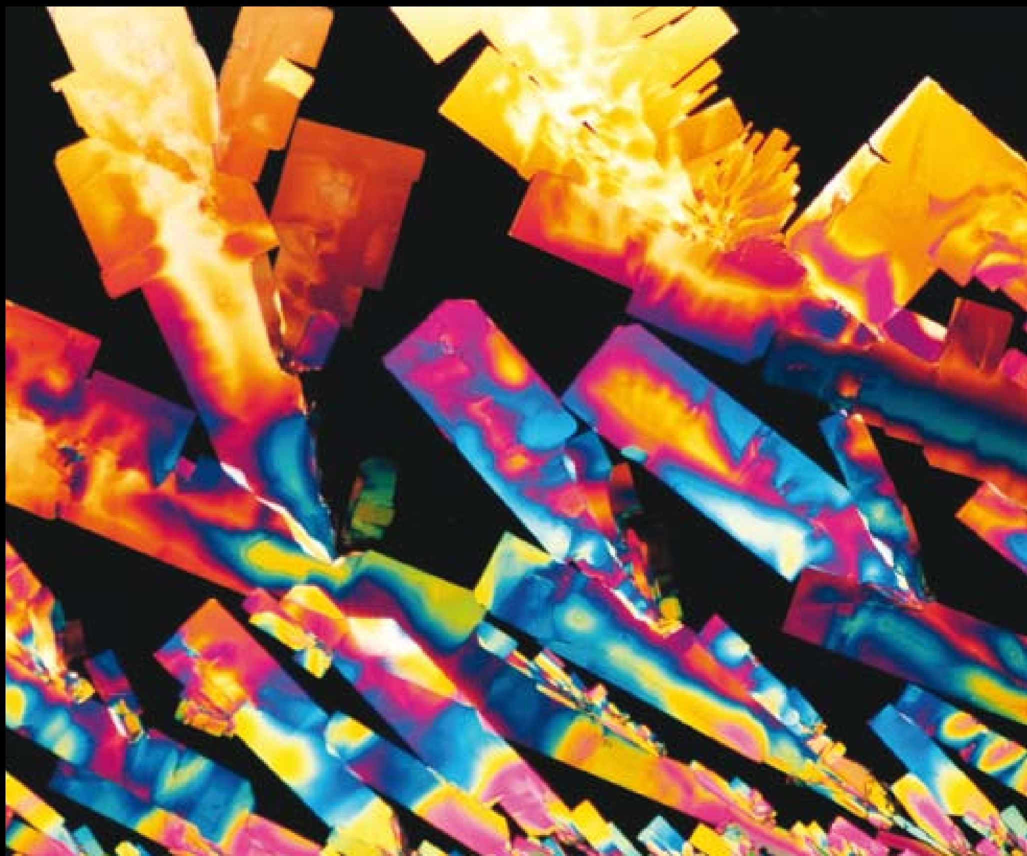

Fig. 14. Ascorbic acid (Vitamin C). Magnification 15X. Field of view = 1.5mm.

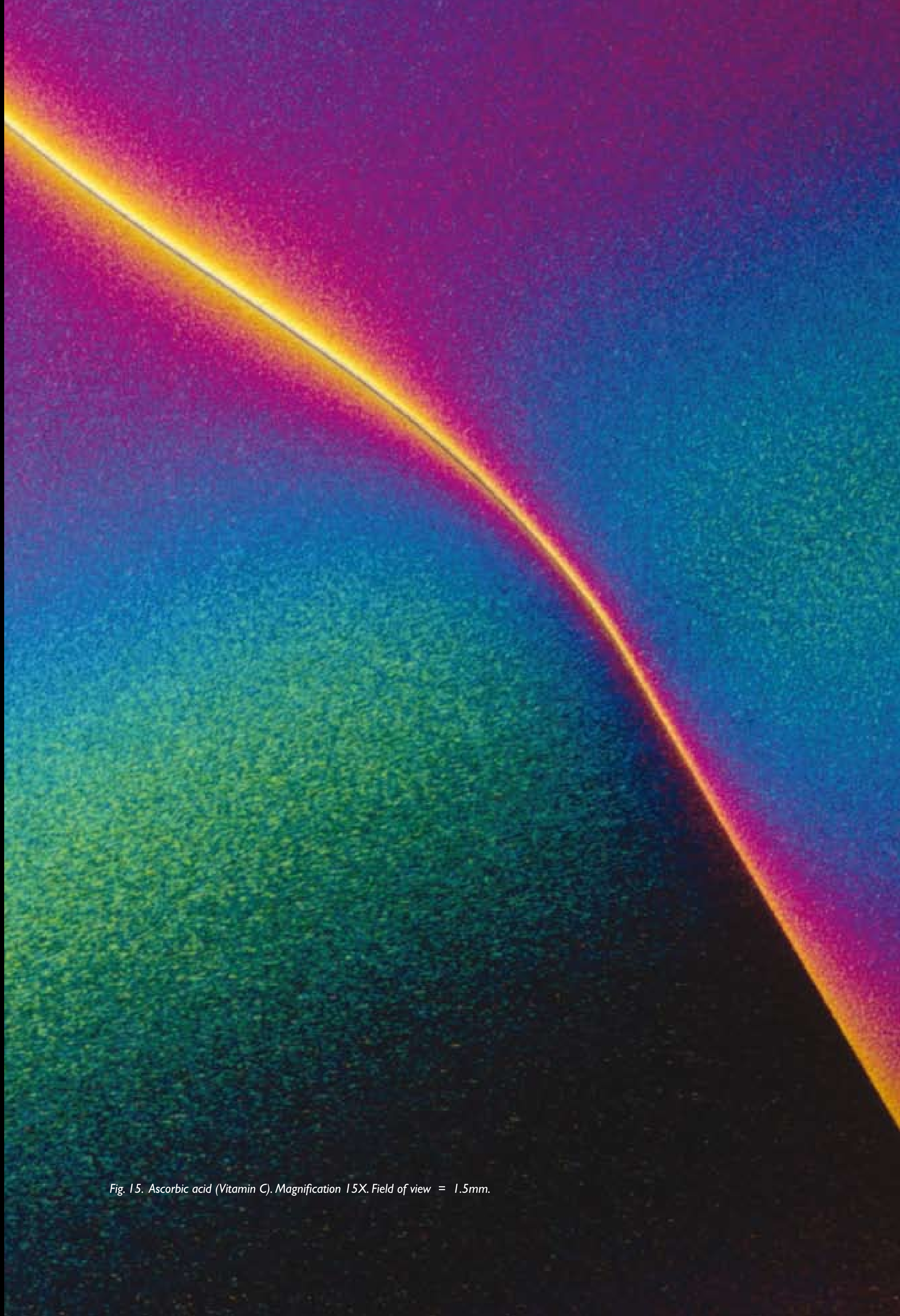

Fig. 15. Ascorbic acid (Vitamin C). Magnification 15X. Field of view = 1.5mm.

Fig. 17. Potassium-ferricyanide. Magnification 40X. Field of view = 0.6mm.

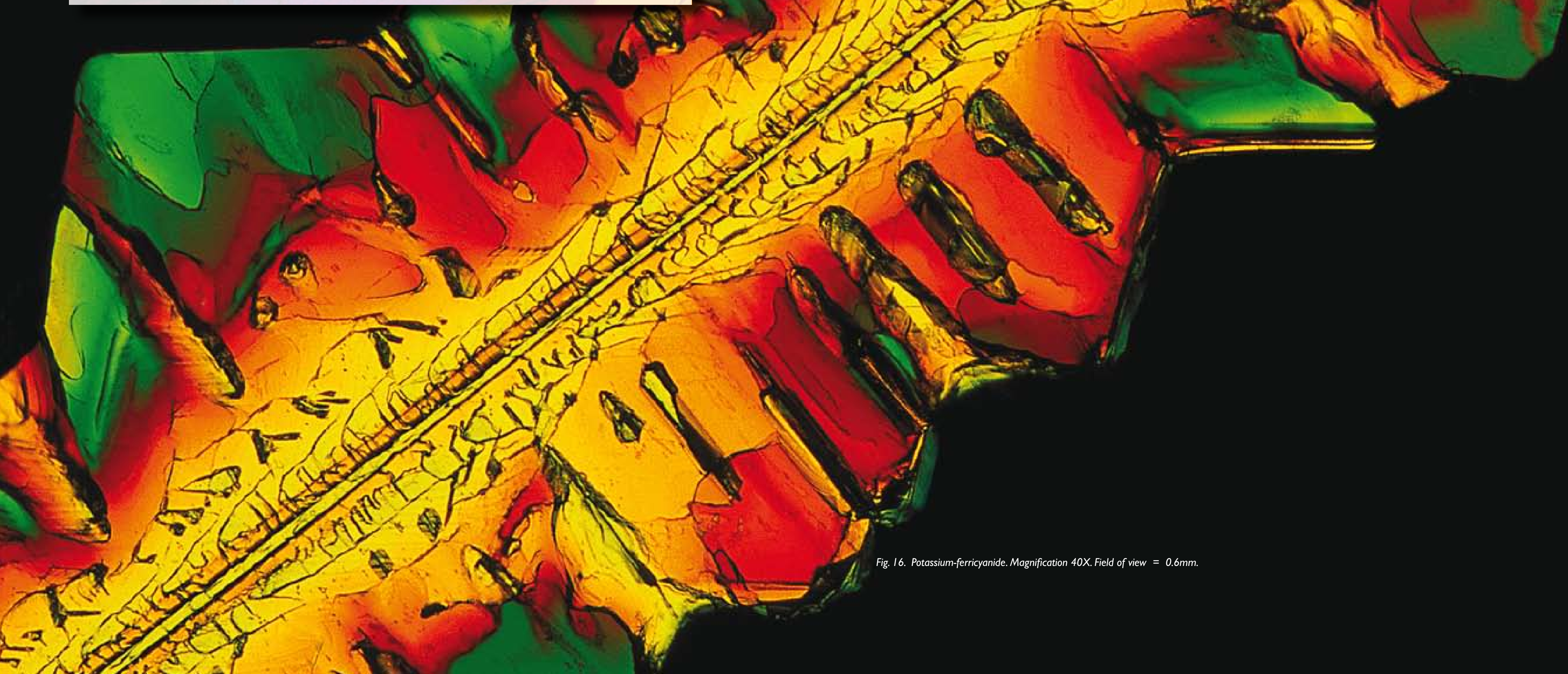

Fig. 16. Potassium-ferricyanide. Magnification 40X. Field of view = 0.6mm.

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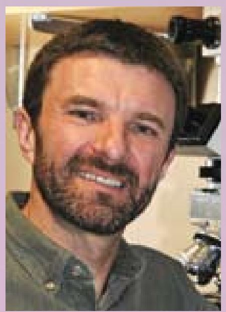

Stefan Eberhard is a Research Professional at the Complex Carbohydrate Research Center (CCRC) at the University of Georgia in Athens, Georgia, USA. He is a member of a research group which is studying the biological functions of cell-wall carbohydrates in plant development. Microscopy and photomicrography are essential tools in Stefan's work, which he uses to examine and document cellular features of in vitro grown plant-cell cultures.

Stefan Eberhard also uses the microscope to produce photomicrographs to explore the beauty of art within science and for aesthetic purposes. Many of Stefan's award winning photomicrographs have graced the covers of magazines, been published in calendars and have been shown at local, national and international exhibitions. Several of his crystal micrographs have also won awards in international photography competitions.

Fig. 18. Sodium thiosulfate. Magnification 40X.
Field of view = 0.6mm.