Images of Inner Space

Art from a microscopic view of everyday materials

By RICHARD LIPKIN

Sunset over the city of Midland, Mich., bathes the industrial landscape in an otherworldly glow. At dusk, this tempered light drifts across the building that houses the microscopy laboratory of Dow Corning Corp.

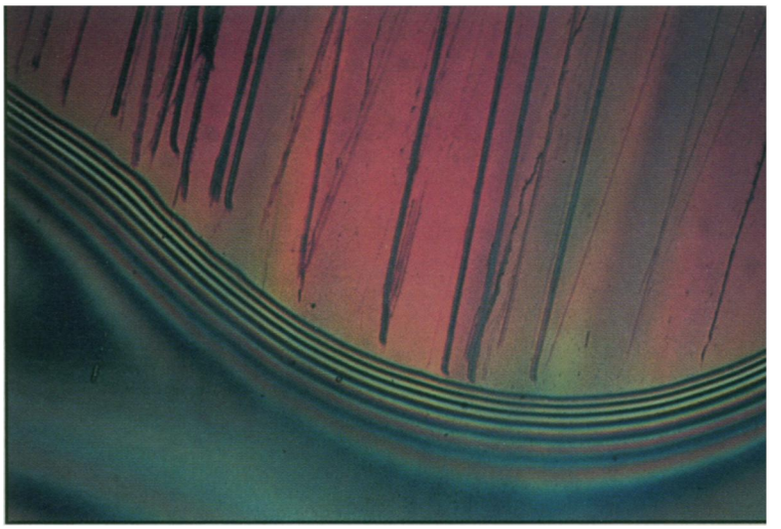
Inside that lab 40 years ago, a materials scientist first peered into a powerful optical microscope, training himself to make virtual sunsets glisten from otherwise drab specimens on a steely mount.

A piece of silicone. A slice of bone. A chunk of an automobile engine. Each object looked like little more than debris. But to Arnold Kolb, a microscopist at Dow Corning, they looked like something else. He discovered that such mundane materials — enlarged hundreds of times, showered with polarized light, and viewed at just the right angle — yielded extraordinary microlandscapes.

Iridescent planes, pathways, and fjords appeared. Mauve and crimson bands coalesced. Silken, undulating waves seemed to form out of nowhere. A crystal could warp light into rainbowlike stripes, its latticed molecules absorbing, reflecting, and refracting different wavelengths.

In this microworld, shorn forms lying on crystalline planes gave rise to a microscopic dawn.

"Pastorale" *(1988) shows the hormone progesterone crystallized, dissolved in solvent, recrystallized, and melted. Magnified 50 times, the hormone is viewed with transmitted cross-polarized light.*



"Interface" *(1989) shows the colorful reflections of an abrasion-resistant coating of liquid resin cured on an acrylic sheet. Magnified 100 times, the resin yields its colors via transmission interference contrast microscopy.*

"A few centuries ago, the arts and sciences were viewed and practiced as natural partners in creative cultural development," says Kolb, 71, who has since retired from Dow Corning to make material images full-time. "Today, our perception and understanding of our world is divided into the factual (the knowledge expressed in words and numbers) and the emotional (the knowledge perceived in images and feelings).

"A world of difference exists between scientists and artists. They have gone their diverse ways and do not have a common basis for understanding of their work and philosophy. With the intensive growth and explosion of our technology, there is a vital need for a recombination of the arts and sciences. A better balance is necessary to enable us to survive as individuals."

A highly trained technical microscopist, Kolb realized that the microscope had great unrealized potential as a visual tool – and as a means of artistic expression. He spent years doing metallurgical research on magnesium alloys, looking at polymers with electron microscopes, performing X-ray diffractions on concrete to show how crystals formed as it cured.

His goal at the time was to study the improvements and failures of new materials. Yet something about these images struck him. "Not only were they technically interesting, but there was something unique about the way the colors and composition came together."

Though he had no training in art, he began to experiment with images. A technical project to show how a silicone emulsion could break up foam for an industrial application generated his first image published as art.

Then he tried concrete. Zooming in on forming concrete crystals yielded artistic works that now bear the names "Construction I" and "Asteroids."

Other images soon followed. Kolb toyed with a wide variety of materials – minerals, chemicals, plastics, and ceramics. He looked at skin, bone, and muscle tissue. He tried pieces of corroding metal. He even photographed crystallized vitamins, drugs, and the hormone progesterone.

In a career that now spans 40 years, Kolb has produced several thousand images, many of which have won him distinction in art competitions. His work has appeared in more than 100 public exhibitions. This summer, his images will appear in a show called "New Directions," presented by the American Association for the Advancement of Science in Washington, D.C.

Kolb calls the realm of his photographs "inner space."

"People generally know what outer space looks like," he says. "But very few people have a good visual sense of what inner space is like. By this I mean the space within the materials we hold in our hands. One of my goals is to open a window into this inner space, to show the inherent order and structure of nature, an order that is nonlinear, naturally patterned, and self-organizing. These images reveal nature's own way of organizing things rather than our engineering processes."

To capture this inner space, Kolb has customized a Zeiss Ultraphot research microscope, outfitting it with an apparatus that will illuminate his specimens with polarized light. The extraordinary colors that emanate from his images come entirely from natural prism effects.

When certain materials are illuminated with polarized light, either by passing light through them or reflecting it off of them, the materials themselves act as prisms. Light diffracts into a splash of rainbow colors. To enhance this process, Kolb uses special optical equipment, such as beam splitters, interference lenses, compensators, and prisms, to enhance color differences and increase visual contrasts.

One optical method – called the Nomarski differential interference contrast system – splits light rays into two separate beams that pass in parallel through a specimen. Areas of the material with different densities or small differences in surface height cause the two beams to travel slightly different distances.

When the beams recombine, the subtle shift between them shows up as a burst of prismatic color. Thus, very tiny gradations in material texture, micrometer-size ridges and fractures, and minute changes in surface elevation show up in strong, colorful relief.

The special equipment, Kolb says, "helps to reveal the beauty of symmetry that lies beneath the surface of our everyday world."

To prepare the specimens for optimal photography, he tinkers with them in various ways, depending on their physical nature. Sometimes he dissolves or melts them, then slowly cools them until they recrystallize. Other times he slices thin, transparent sections. With opaque metals, he may grind and polish them to a mirror finish, then etch them to bring out the material's unique qualities.

Kolb likens this process to directing a theatrical production. First, he says, he must "bring the characters of the visual drama onto the stage of the microscope." If the members of the cast are "not properly costumed or suitably placed," he calls for another "rehearsal or recasting." This involves "melting or dissolving

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"The Web" *(1971) shows the polished and etched surface of a gray iron casting taken from an automobile engine block. When magnified 800 times and viewed with reflected polarized light, layers of ferrite and a darker cementite give rise to colors.*

Photos: Kolb

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the preparation, then recrystallizing or recreating the artistic scene until a suitable stage presentation is achieved."

"Finally," he adds, "the curtain, or camera shutter, goes up."

A case in point is the image called "Pastorale." Here, Kolb took crystals of the hormone progesterone and melted, cooled, and recrystallized them several times. For quite a while, nothing interesting showed up. But as he rotated the slide, an intriguing image suddenly sprang into view. It bore an uncanny resemblance to a landscape.

Getting the composition to fall properly into the visual frame took some doing. Regions immediately adjacent to the image did not fit the picture. "Much time went into adjusting the optics, the orientation, the magnification, and the lenses to selectively include just the right portion," he says. But the result — a picture of a lush valley — congealed by itself on the crystal surface.

Another image, "The Web," grew out of a study of corrosion on an automobile engine casting. The chunk of metal, measuring one-half inch by one-quarter inch, shone a drab gray. To generate color, Kolb polished and etched the metal, then subjected it to reflected cross-polarized light, using the differential interference system. In particular, the etching helped to highlight the iron alloy's crystal structure, especially the ferrite's lamellar shelves and graphite flakes. Different surface elevations yielded a rainbow of colors.

"It reminds me of a cave painting, a petroglyph," Kolb says.

An image called "Interface" arose from the surface of a plastic thin film used as a scratch-resistant coating for acrylic and aluminum parts. The product, called Silvue, protects eyeglasses and autos from scuff marks.

For this image, Kolb selectively coated an acrylic plate with the special resin, then dragged an abrasive cloth across the surface, scratching the uncoated acrylic areas but not the coated ones. When viewed with transmitted interference light, colors beamed through, their hues varying with the depth of the scratches.

"I'm convinced that many scientific investigations stem from aesthetic visions or concepts," says Donald R. Petersen, an X-ray crystallographer who edits the JOURNAL OF TESTING AND EVALUATION. "You might call this accidental art, because one doesn't look for it — it just happens. What Arnie Kolb has done is to capture the artistic aspects of his investigations."

"People working in materials science already appreciate the beauty of materials," Petersen adds. "But people outside the field don't see it. You need a trained eye. Kolb's images make this beauty evident, which helps people see the link between science and art. It's not terribly useful to think of art and science as existing in two separate boxes."

Instrumental in Kolb's development as an artist was Alden B. Dow, an architect and son of the founder of Dow Chemical Co. Dow's belief in the synergy of art and science led him to establish the Alden B. Dow Creativity Center at Northwood University in Midland, where Kolb became a research fellow.

"If you believe that artists should make people aware of the beauty of their natural surroundings, then Arnie Kolb certainly does that," says Carol Coppage, the center's director. "Not to mention that his images come from a world that most of us don't ordinarily see. After all, how many people can use high-powered microscopes to look at the inner world of nature?"

Kolb has set himself this very objective. "As a researcher in the field of materials science, I have been intrigued and inspired," he says. "The enormous variety and beauty of form and color in the natural designs of our microworld, as seen through the microscope, can be overwhelming. Our awareness of our natural surroundings depends on what we can see or sense. What lies beyond our senses goes unrecognized. The microscope allows us to expand our vision beyond the obvious to see and experience a whole new universe." □