.tech-niques tomorrow
by Bennett Sherman

Vivitar tackles a tough task—a long-focus mirror lens with a plastic element.

The name Vivitar has cropped up in this column quite a few times in the past year or so—and with good reason. More than once this American company has shown that innovation in the 35mm camera field is not the sole province of the Japanese manufacturers. And they're about to show us yet another proof of that fact. Although they haven't always been pleased with the financial results and, on rare occasions, not satisfied with the technical achievement, Vivitar has pioneered many ideas for our SLR cameras. Not the least among these were the Series 1 lenses, a group of extremely high performance zoom lenses and telephotos. They showed what could be done by combining excellent design—by an American, Ellis Betensky—and rigid, tight manufacturing tolerances. The "solid cat," a nearly-all-glass, mirror telephoto originally from another American company, Perkin-Elmer, is a further example of the daring chances Vivitar has been willing to take. Vivitar, alone among the smaller American optical companies, has worked primarily in the 35mm camera and lens business, once almost exclusively the Japanese game. Now, when Vivitar undertakes the development and marketing of a new mirror telephoto, it is with great interest that we examine their results closely.

Plastic impressions

The new 450mm telephoto shown last October at Photokina, the great international photographic fair in Cologne, West Germany, was most impressive. We were even more impressed when we found out that the lens has a thick, precisely made plastic element with an aspheric surface. The light rays pass through the plastic three times, making the total path through this novel lens element more than 3 in. This column has featured many reviews and analyses of plastics in cameras and lenses. Several times, we said plastics do not seem to be useful for large, long focus optics. Discussions with international experts in optical design, who have tried plastics for larger lenses, seem to bear out this negative

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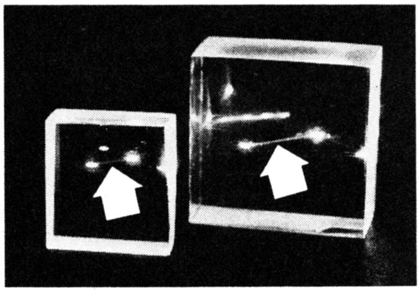
feeling. So, when Vivitar undertakes the design and manufacture of a long focus mirror-telephoto with a thick plastic element, we wonder if there is something new or whether Vivitar may be unhappily surprised when these lenses are manufactured in quantity. What were the problems Vivitar engineers faced with this lens?

To begin with, we have to understand the very atomic nature of plastic and how it is different from glass. Glass is a mixture of (mostly) oxides, and the atoms do not form any regular pattern, as are found in crystals. When the molten liquid of silicon dioxide (the main constituent of sand) and other chemical oxides, cools, the atoms form short, irregular chains. Plastic also "cools" or dries out and the atoms form chains. But the atomic chains in plastic are tremendously long—perhaps a thousand times longer than those in glass. As a result, the surface of plastic cannot be made as smooth as glass. Although it may transmit light very easily, there is a slight haze, almost unnoticed in ordinary use, due to scattered light from the surface. The long atomic chains also tend to produce internal scattering, adding to the haze. Plastics manufacturers have a standard of haze—about two or three percent of the light passing through.

To show this internal and surface scattering, we set up a small, low-power helium-neon laser and sent the beam directly through well-polished blocks of glass and plastic. In the darkened room, we could see the laser beam passing through the plastic, but the beam was almost unnoticed in the glass block. The beam striking the surface of the plastic lit up much more strongly than where it passed the glass surface. Back in the 1960s Arthur Cox showed how plastic optics tended to have lower image quality near the diffraction limit of performance due to local scatter. That is, the light was also scattered ahead slightly off line from the true position, broadening the diffraction-limited image. However, in recent years, better plastic materials have been developed, with better techniques of formation, reducing some scattering problems.

Just how far have we come in the development of plastic optics for high performance lenses? Vivitar feels that new methods for working the surface of the plastic elements, methods similar to those now being used for glass, and improved plastic, with less internal strain (a cause of haze and scattering in plastic and glass), can be relied on to yield a superior lens element. Ellis Betensky, who was a principal optical designer of the Series 1 lenses, and is the designer of the new mirror telephoto, believes the lens can be made in quantity,



See how they spread: Beam from small helium-neon laser passed through glass, left, and plastic blocks reveals essential difference between materials. Plastic scatters it more strongly. Bright spots at ends of each line are surface reflections of beam.

accurately and profitably. He notes that the plastic element is not being used with steep, highly curved surfaces. In the past, these have been a problem. The plastic is now inside the lens, sealed from harm caused by the atmosphere—moisture and chemicals.

Even if the lens does not, in the final analysis, turn out to be a financial success, it still represents an important new step in camera lens design. The optical problems we have discussed here may not be as bad as we fear. The ultimate sharpness such as we might demand in a fine astronomical telescope of moderate aperture, is not the same as our needs in a camera lens.

It may be possible that, under the right conditions, a mirror telephoto could, for example, be made with a plastic element up front, in the thin corrector lens. Once we have passed the hurdle of a first serious attempt at making high precision plastic elements for our 35mm SLR lenses, others may follow.—THE END