# NASA TECH BRIEF

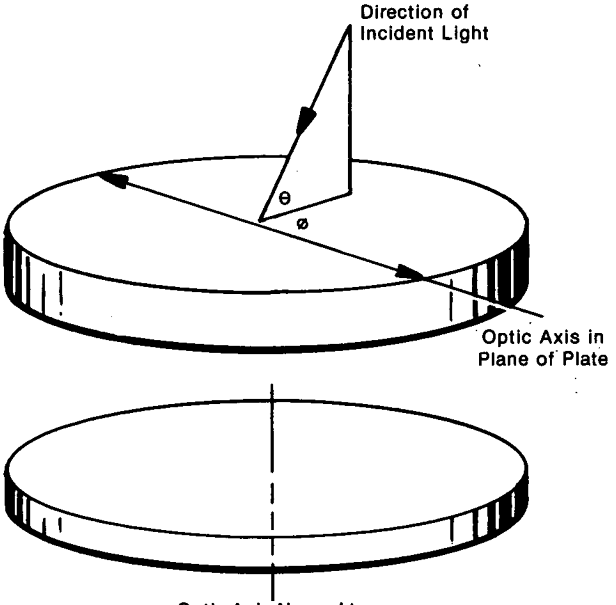
*Lyndon B. Johnson Space Center*

NASA Tech Briefs announce new technology derived from the U.S. space program. They are issued to encourage commercial application. Tech Briefs are available on a subscription basis from the National Technical Information Service, Springfield, Virginia 22151. Requests for individual copies or questions relating to the Tech Brief program may be directed to the Technology Utilization Office, NASA, Code KT, Washington, D.C. 20546.

## Wide-Field Birefringent Elements

Birefringent elements are employed in different optical systems, for example as biasing elements in electro-optical modulators and as wavelength-determining elements in special color filters and more complex optical networks. For best performance, especially if the system is to be fast, the birefringent retardation in these elements should be independent of the direction of incident light at each point on the elements.

A newly-proposed birefringent array consists of two plates with the retardation properties nearly independent of the direction of incident light over an unlimited range of wavelengths. The two plates shown in the illustration are made from the same material; the thickness of the plate with its optic axis in the plane of the plate is twice that of the other.




Birefringent Array

The birefringent retardation Γ is a function of the angles Θ and Φ that specify the direction of the incident light. A general expression for such a function is

$$\Gamma = \Gamma_0 + \Theta f_1(\Phi) + \Theta^2 f_2(\Phi) + \Theta^3 f_3(\Phi) + \Theta^4 f_4(\Phi) + \ldots,$$

where $\Gamma_0$ is a constant and $f_1(\Phi)$, $f_2(\Phi)$, $f_3(\Phi)$, etc., are functions of Φ only. For this array, it can be shown that when Φ is any integral multiple of 45°, the functions $f_1(\Phi)$, $f_2(\Phi)$, and $f_3(\Phi)$ vanish. The net effect is that the optical behavior of this array is more independent of the direction of the incident light than is a simple retarder regardless of the wavelength.

The array can be used as a birefringent color filter. The wavelength response of a birefringent color filter is changed by altering the retardation of each element. This is done by changing the temperature of the entire array. If both plates in the element are made of the same material, their optical properties vary in precisely the same way, and the thickness ratio remains very nearly 2:1 at all temperatures. The result is an element with a thermally-adjustable birefringent retardation that is independent of the direction of the incident light.

The optical properties of the plates may also be changed electro-optically rather than thermally. Electrical signals should be applied to both plates in order to change their optical properties synchronously. However, in some cases it may be practical to vary only the optical properties of the plate with its optic axis in the plane. The thickness of the other plate then must be selected to produce angular compensation when the optical properties of the first plate are midway between their extreme values. In this way a fair degree of angular independence can be obtained for all values of the resultant retardation.

(continued overleaf)

**Note:**

No further documentation is available. Specific questions, however, may be directed to:

Technology Utilization Officer
Johnson Space Center
Code AT3
Houston, Texas 77058
Reference: B75-10105

**Patent status:**

NASA has decided not to apply for a patent.

Source: A. Miller of
RCA Corp.
under contract to
Johnson Space Center
(MSC-12677)