Beyond the Grating Equation: Light Patterns in the Era of Diffractive Optics

D. C. O'Shea
SPIE President and Professor of Physics, School of Physics
Georgia Institute of Technology
Atlanta, GA 30332 USA
doshea@prism.gatech.edu

The interaction of light with periodic patterns generates beautiful color patterns and interesting applications. The basic equation for understanding this phenomena is the grating equation. It tells us the angles, relative to a perpendicular to a grating with a specific period, into which light of a specific wavelength will be diffracted. But what it does not tell us is how much light will be directed into the various "orders" of the grating. It was found that by controlling the shape of the diamond point used to cut the periodic structure into the substrate, a traditional grating could be made to direct most of the light diffracted from it into a single order. This type of grating is referred to as a "blazed" grating.

Now that optical surfaces can be fabricated using microlithographic techniques, the distribution of light into the various orders can be exquisitely controlled using various diffractive optical elements. After a short review of the techniques and concepts of diffractive optics, two examples of non-conventional grating use will be discussed. The first uses phase gratings to generate near field periodic light patterns (Talbot images). By observing these patterns in convergent light, it is possible to answer the question: Where does the Fresnel region end? In the second application two binary phase gratings are combined to produce a grating with a variable blaze. This device can be used as compact light modulator.