What different types of polarizers are available?

Electromagnetic radiation is a transverse wave with mutually perpendicular electric and magnetic fields that are also perpendicular to the direction of propagation of the wave. The plane defined by the electric field vector and the direction of propagation is referred to as the plane of polarization of the electromagnetic wave. The electric rather than magnetic field is chosen for the definition of the plane of polarization because it is the electric field that significantly interacts with matter. In a spectroscopic measurement, it is often important to control the polarization of the incident radiation. This is readily achieved with optical devices called polarizers. There are several types of polarizers.

The type of polarizer most often used in FTIR spectroscopy is a wire grid polarizer. An array of extremely fine metal wires is deposited on a face of an optically transparent window (usually KRS-5 or ZnSe). Since the electric field oriented along the direction of wires can induce electrical currents along the wires, the wire grid acts as a metal surface reflecting virtually all the radiation polarized along the direction of the wires. The electric field perpendicular to the direction of wires is unable to induce electrical current in the wire grid. Thus, the light transmits through the polarizer with only the reflectance losses from the substrate window. The efficiency of wire grid polarizers is much higher for wavelengths that are much longer than the grid spacing. This makes wire-grid polarizers useful in the mid-IR and especially in the Far-IR.

Another type of polarizer, called the Brewster's angle polarizer, is constructed by stacking transparent plates in the beam tilted so that the angle of incidence on the plates is Brewster's angle. Since at Brewster's angle, the reflectivity of p-polarized light is zero, the p-polarized component passes through the plates without loss, while the s-component intensity is reduced by reflectance losses at every surface. The intensity reduction of the s-component depends on the strength of the reflectance as well as on the number of plates utilized. In the mid-IR region, transparent materials of very high refractive index are available (i.e. Si and Ge). Thus, it is possible to construct a polarizer with a sufficient polarizing efficiency that utilizes only two plates.

For the near-IR and UV-Vis spectral regions, the polarizer of choice is a Glan-Taylor polarizer or Glan-Thompson polarizer. These polarizers are based on the birefingent property of some materials. These materials have different refractive indices for different polarizations. The light is brought onto an internally reflecting interface at an angle of incidence that is below the critical angle for total internal reflection for one polarization and above critical angle for the other polarization. Thus, the unwanted polarization is deflected out of the beam while the wanted polarization is passed through. This yields a polarizer with a very high polarizing efficiency that is essentially constant throughout the transparent spectral range of the crystal.

Note: Polarization is defined relative to the plane of incidence, *i.e.* the plane that contains the incoming and reflected rays as well as the normal to the sample surface. Perpendicular (s-) polarization is the polarization where the electric field is perpendicular to the plane of incidence, while parallel (p-) polarization is the polarization where the electric field is parallel to the plane of incidence.