Instrumental technique

Deuterated triglycine Sulphate (DTGS) detector
(pyroelectric IR detector)

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Introduction:

IR spectroscopy is the subset of spectroscopy that deals with the infrared region of the electromagnetic spectrum. It covers a range of techniques, the most common being a form of absorption spectroscopy.

It provides methods for studying materials in all three states ,i.e., solid, liquid or gas .
IR spectrum covers the following range of the electromagnetic range:

Near IR	15000 cm-1 to 4000 cm-1	0.67 µm – 2.5 µm
Mid IR	4000 cm-1 to 400 cm-1	2.5 µm – 25 µm
Far IR	400 cm-1 to 10 cm-1	25 µm – 1000 µm

Essentially the IR instruments consists of the following components:

1. The stable source of radiant energy
2. Wavelength selector that permits the selection and isolation of a restricted wavelength region
3. Sample compartment
4. The detector and
5. A signal processor and readout.

Detectors in FTIR

Two most popular detectors for FTIR spectrometer are:

1. Pyroelectric Detector: Deuterated triglycine sulphate (DTGS).

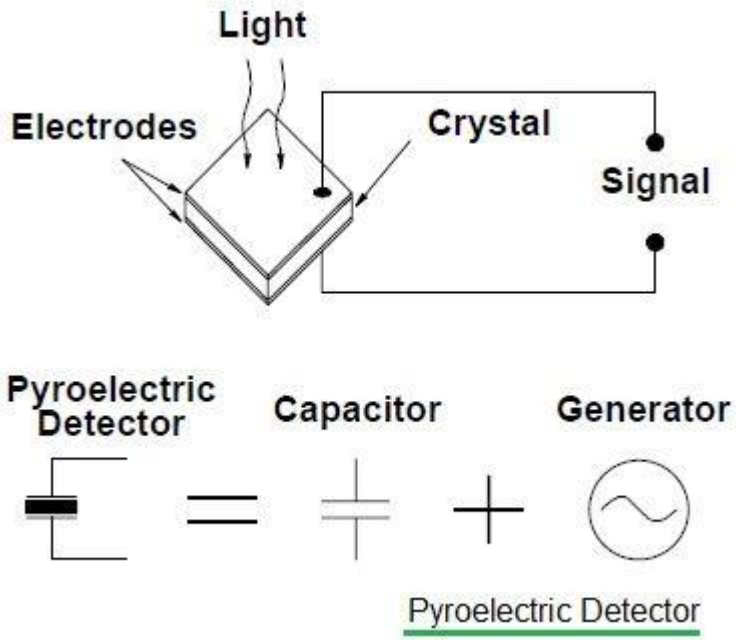
It is a mid IR detector

2. Photon-sensitive semiconducting Detectors: Mercury cadmium teluride (MCT)

Thermal Detectors are not used in FT IR:

• The response times of thermal detectors (for example, thermocouple and thermistor) used in dispersive IR instruments are too slow for the rapid scan times of the interferometer.

Pyroelectric Detector working principal:



Pyroelectric detector or sensor is combination of capacitor and charge generator. It is referred as charge generator due to the fact that when infrared light strikes on the face of detector, it is absorbed as heat. This will create polarization. The device does not require any kind of cooling or biasing of any sort in order to perform.

- Pyroelectric materials change their electric polarization as a function of temperature. These materials may be insulators, ferroelectric materials or semiconductors.
- A dielectric placed in an electrostatic field becomes polarized with the magnitude of the induced polarization depending on the dielectric constant. The induced polarization generally disappears when the field is removed.
- Pyroelectric materials, however, stay polarized and the polarization is temperature dependent.
- It consists of a thin single crystal of pyroelectric material placed between two electrodes. Upon exposure to IR radiation, the temperature and the polarization of the crystal changes. The change in the polarization is detected as a current in the circuit connecting the electrodes.
- The signal depends on the rate of change of polarization with temperature and the surface area of the crystal.
- Pyroelectric material mostly used as an IR detector is Deuterated triglycine sulfate(DGTS).

Deuterated lanthanum triglycine sulfate:

Triglycine sulfate (TGS) is a chemical compound with a formula $(NH_2CH_2COOH)_3 \cdot H_2SO_4$. The empirical formula of TGS does not represent the molecular structure, which contains protonated glycine moieties and sulfate ions. TGS with protons replaced by deuterium is called deuterated TGS or DTGS.

DTGS crystals are formed by evaporation of an aqueous solution of sulfuric acid, which is containing a greater than three-fold excess of glycine.

DTGS crystals are pyroelectric and ferroelectric and have been used as detector elements in infrared spectroscopy for mid-infrared range measurement that employs temperature-sensitive ferroelectric crystals of DTGS

As the temperature and hence polarisability of the crystals changes (due to the absorption of infrared radiation) a charge is generated which is detected by two parallel electrodes. The deuterated forms of the crystals are used because they have a higher Curie point.

Thank you