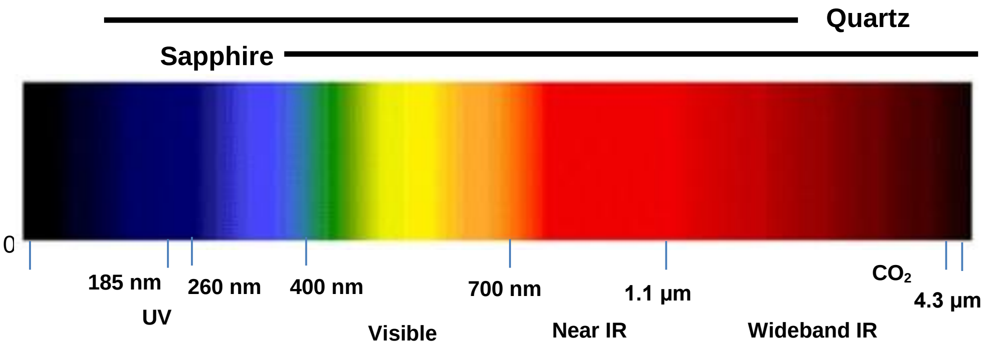
The Spectrum



The Spectrum.

The electromagnetic spectrum includes high frequencies (high energy) such as γ-rays and X-rays, ultraviolet, visible light, infrared and to low energy waves like radio waves and microwaves. Flame detectors typically detects a fire with help of UV, IR and sometimes visible light. A human being uses his/her sensors to "detect" a fire by visible input, heat sensors in the skin and even detect smoke gases by smelling. Our brain uses a natural algorithm to recognize it and respond to a fire situation. A flame detector also uses sensors and logic to generate an alarm. The more sensors we can make and the more processing power we have to calculate the algorithms the more reliable the detector is.

A Ultraviolet (UV) sensor for a flame detector is made for radiation input of 185 to 260 nm. This range is least effected by natural sources such as cosmic radiation and sunlight. Gases, vapor and smoke in the atmosphere filter the sunlight but also oil and grease on the window blocks the detector. Beware of these inhibitors because you won't know that they are there. Virtually every fire emits UV radiation and therefore the UV flame detector is a good "all round" detector. False alarm sources for UV detectors are Halogen and Quartz lamps without the protective glass, Arc welding, Corona and Static Arcs.

A Visible light sensor (0.4 to 0.7 micron) is able to produce a signal that people can understand and process. Visual Flame Detection is based on analyzing pixels using sophisticated algorithms. Still the camera detector can be blinded with smoke or fog. It is also possible to mix the images of the visible camera with a UV camera. The Corona camera is an example of this technology. It is used for sensing defects in high voltage installations and also makes fire detection possible over large distances under ideal conditions.

A Near Infrared sensor (0.7 to 1.1 micron) is less effected by water and water vapor. Used for the detection of e.g. munition fires or embers in air ducts. This sensor is not solar blind.

A Wide band IR sensor (1.1 micron and higher) looks at the heat of fire. A special frequency is 4.3 micron. This is the resonance frequency of CO_2. When burning a Hydrocarbon such as Wood, Gasoline or Natural Gas this energy is released. It causes a peak in the spectrum that can be easily detected. When the CO_2 cools down it starts absorbing the 4.3 micron energy. This is typical for all elements: when they are hot send out radiation in their resonance frequency and when they are cold they absorb energy in that same frequency. The cold CO_2 filters the sunlight away (at sea level) and makes the IR detector Solar blind. By analyzing the flicker frequency of a fire (1 to 20 Hz) IR detectors can be more false alarm resistant. Multi IR detectors use algorithms to suppress the effects of blackbody radiation. This always makes the detector less sensitive since the blackbody radiation masks the fire. Sunlight has the same effect.

A disadvantage of IR detectors based on 4.3 micron (appr. 3.5 micron and higher) is that some energy in that range may be absorbed by water (ice and water on the detector window). I.e Fog, snow or water spray decrease the sensitivity of the detector. By correctly aligning the detector in many applications the contamination of the detector window with water or ice can be avoided. Also a part of the problem can be solved by a "through the lens" self-test of the detector window so you know that the transmission through the window has decreased by the absorption. In severe environments heating can be included the detector window to vaporize the water.

A sensor must be protected from the environment by a housing with a window. That window must be able to transmit the radiation you are looking for. Different materials have different filter properties. Quartz can be used for UV detectors but not for 4.3 micron IR flame detectors. Sapphire is suitable for IR (up to appr. 6 micron) flame detectors but only for UV radiation when the window is less than 3 mm thick and it is much more expensive. In the picture above you can see the ranges that are involved with the transmission of the Quartz and Sapphire windows.