

JP Innovations, LLC

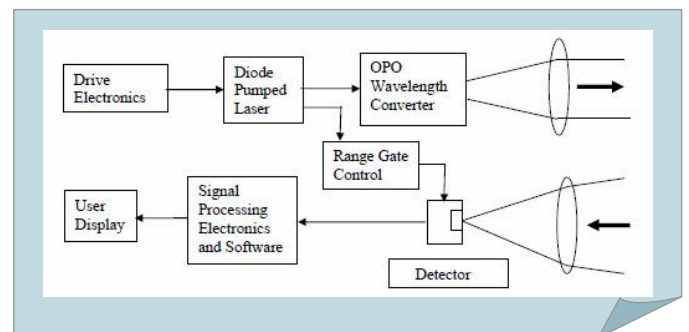
Mine Hazardous Gas Laser Detection System

There is a strong need to detect atmospheric hazards in mines, especially coal mines. These hazards come in various forms, with a build-up of Carbon Dioxide (CO₂), Methane (CH₄), Carbon Monoxide (CO) and other gasses as well as particulates, mostly made up of Carbon (C) particles, which can be hazardous in high concentrations in the air. The sensor approach proposed by JP Innovations, LLC can detect and measure the presence of CO₂, CO, CH₄, Carbon, and possibly other gasses as well, significantly increasing the utility of the sensor.

The detection approach uses a pulsed laser beam transmitted through the air column with a measurement of the backscattered radiation at several carefully selected wavelengths. These gasses have unique absorption features in the infrared region of the spectrum. Near the optimum wavelength for the particular gas to be measured, the amount of absorption of the transmitted light varies strongly according to the wavelength for each particular molecule, and this creates unique molecular “signatures” for these gasses. Therefore a method called “Differential Absorption LIDAR” (DIAL) can be used to determine the concentration. The large dust particles also backscatter radiation, but their scattering is much less wavelength dependent. So with a wide selection of laser wavelengths, the presence and concentration of these gasses and dust can be measured. The transmitter will produce only one of these wavelengths at a time, and the receiver will record the magnitude of the back-scattered signal at that particular wavelength.

The laser system used for these measurements must be tunable (in steps) across this portion of the electromagnetic spectrum, commonly called the Mid-Wave InfraRed (MWIR). The laser must also be capable of pulsing at significant repetition rates (due to the large number of measurements that need to be taken) but also with very short pulse duration, ideally of the order of less than 10 nanoseconds. These lasers can be built using Diode-Pumped Solid State (DPSS) laser technology, and have been built by JP Innovations for many years. Since the measurement range is short, the transmitter will be designed to have relatively low output pulse energy. It is anticipated that the beam that is transmitted down the mine tunnel will be “eye-safe”. Both the transmitter and receiver technologies for this system are well developed, but for optimum operation and maximum measurement accuracy both the transmitter and receiver will need to be designed and engineered specifically for this application.

We expect the Coal Mine Hazard Sensor to be capable of making a set of measurements, analyzing the data and presenting the results within < 30 seconds, depending on the number of wavelengths and gasses that are going to be measured. The spatial resolution down the length of the tunnel should be better than 3 meters, and the measurement range will be up to 100 meters or longer, if such a long path is clear of blocking obstructions in the mine environment. It is important to note that this sensor will not be able to measure “around” corners and it cannot look “through” tunnel walls.



JP Innovations, LLC designs and delivers solid state diode pumped lasers (DPSS), eye safe lasers, compact high pulse energy lasers, high peak power 2 ns lasers, optical parametric oscillators, and other non-linear optical systems that can be used for LIBS, LIDAR, medical, bathymetry, designator, illuminator, and other industrial or military applications. If your application requires a custom laser solution, JP Innovations will build it for you!

