Ultra Low Cost Refract Meter with Longitudinally Attached Optical Fibers

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Abstract—*A multimode optical fiber based method for measuring refractive index of transparent liquid sample is reported. Two longitudinally attached fibers are used in the sensor setup, where one fiber acts as a Light Emitting Fiber (LEF) and the other acts as Light Receiving Fiber (LRF) in the sensor setup. The two fibers are longitudinally glued together such that there is distance of ~2mm between the tips of the two fibers. The core of the tip of the LEF is polished into a spherical shape. While approximately 2mm of LRF's of jacket and cladding has been removed on LEF's side near the tip of the fiber. Also a silver layer is coated on the flat tip of the LRF, which acts as a reflecting mirror for the light travelling through the LRF core. Laser source attached to the LEF acted as the light source for the sensor setup, the optical coupling between the LEF and LRF is observed, and is found to be varying when the sensor setup is inserted into liquids of different refractive indices. From experimental observation, it is found that the sensor setup can measure refractive index up to a resolution of* 10^{-4} .

Working Principle: The light is coupled to LEF from a laser diode. When this light gets emitted from the other end of the LEF, which has given a spherical shape produces diverging cone of light. This light reaches the decladded portion of the attached LRF and gets coupled with it. This optical power coupling between LEF and LRF varies with variation of refractive indices of the liquid samples used as the media. The solid angle of the cone of light will decrease with increase in the refractive index of the sample medium.

Experimental Details: A 25mW laser diode (LD) having peak wavelength of 650nm is used as light source. A little portion (~0.5mm) of LEF's is decladded at one end. The tip of this decladded core has been polished to a spherical shape. While the ~2mm of the LRF is decladded near the tip of the fiber in one side and the tip is covered with silver coating so that it behaves as a reflecting mirror for the light travelling through it. Now the two fibers have been glued and attached together by placing the spherical tip of the LEF near the bottom of the decladded portion of the LRF so that maximum coupling of light energy can take place between LEF and LRF. These two fibers are used as sensing arm in the sensor setup. While another two fibers attached in the same manner are used as a reference arm. Two photo detectors (PD) and a 10-bit data acquisition system (DAQ) are used for detection and processing of the light beam coming out from the sensing and reference arm. Experimental data are recorded by inserting the reference arm into different water-propylene glycol mixtures having different concentration i.e. having different RI while keeping the reference arm inserted into water all the time.

Results: The light-power at the output (in volts) has been plotted against the different RI of liquid samples. The results agree with the theoretical values of water-propylene glycol mixtures of different concentrations. The sensor sensitivity is strongly comparable with other reported techniques based on Fiber Bragg Grating and Surface Plasmon Resonance with a precision level of 0.00001.