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A Sensor Utilizing Near IR Spectroscopy for the Geo-Environment

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This poster presents the usefulness of near infrared optical fiber analysis for sensing moisture and liquid hydrocarbons in soil. We have carried out physical experimentation using sensing probes that we developed, comprised of optical fibers that utilize the evanescent field of the guided energy. The movement of water through dry sand was simulated in the laboratory and the sensors were used in-situ to measure the aviation of soil moisture in real time. A similar experiment simulated the movement of an organic liquid (mineral oil) through water-saturated sand, and the sensors were used in-situ to monitor the hydrocarbon movement. We found that a hydrophobic polymer-coated wave guide can amplify the hydrocarbon signal while minimizing that of water, making it possible to detect a dissolved hydrocarbon. Tests show that the second derivative transforms, of the absorption spectra could be used to distinguish classes of hydrocarbons.

Our results show that near infrared spectroscopy through optical fibers is capable of in-situ monitoring of moisture and hydrocarbon transport within porous media. Flow experiments conducted to test the sensor's response to changes in moisture content recorded water saturations ranging from 5% to 100% as the wetting front made contact with the sensor. Capillary transport of water in a column also responded to water saturation changes ranging from 15% to 100% (the lowest measured water saturation was dictated by the sampling speed, so the reported 15% is not an indication of the measurement lower detection limit). Cyclic olefin copolymer was shown to be an effective lipophilic polymer for coating the optical fibers enabling measurement of dissolved species. Finally, the near infrared absorption signatures of three classes of hydrocarbons reveal distinct signatures that can be used for their identification.

The application for this work within the geo-environmental context is extremely varied. The sensor could be used as a tool for on-site, real-time evaluation of contamination in air, water and soil specimens. The probe could also be used for real-time analysis of in-situ conditions (e.g. waste containment monitoring, landfill monitoring). Furthermore, new approaches for landfill design based on a bioreactor are being investigated which would require in-situ monitoring of leachate quality in real time (Reinhart et al. 2002). Our results show the possibility of developing the technology for such purposes.