Abstract

Sensors and Actuators B: Chemical
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doi:10.1016/j.snb.2011.06.081 | How to Cite or Link Using DOI
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Tunable Mid-Infrared Lasers in Physical Chemosensors towards the Detection of Physiologically Relevant Parameters in Biofluids

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Received 30 September 2010; revised 26 June 2011; accepted 30 June 2011. Available online 7 July 2011.

Abstract

Mid-infrared (mid-IR) laser spectroscopy is introduced as a physical chemosensor for liquids. Mid-IR sensor systems measure vibrational spectra of samples under investigation and thus are able to directly access chemical information. In this work, a pulsed External-Cavity Quantum-Cascade Laser (EC-QCL) with a 350 mW maximum emission power at 1180 cm^{-1} and tunable from 1030 cm^{-1} to 1230 cm^{-1}, was used for transmission measurements of physiological solutions with pathlengths > 130 µm, thus significantly improving the measurement capabilities of mid-IR sensors employing thermal emitters. The first part of this paper discusses the characterization of the EC-QCL using time-resolved FTIR spectroscopy. Moreover, a comparison of the achievable performance of the physical chemosensor as opposed to a standard FTIR spectrometer is included. Results on the direct determination of glucose in spiked human serum in the physiologically relevant concentration range from 30 mg/dL to 400 mg/dL are reported. Furthermore, spectra of albumin, urea, lactate and phosphate in aqueous solution recorded with the EC-QCL chemosensor are shown, indicating its capability for simultaneous multi-analyte detection.

Keywords: Quantum Cascade Laser; Physical Chemosensor; Glucose; Lactate; Albumin; Urea; Phosphate; Blood; Serum; Mid-infrared; Spectroscopy; large pathlengths

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