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DIODE LASER SPECTROSCOPY ON GAS DISPERSED IN SCATTERING MEDIA

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A novel field of diode laser spectroscopy is demonstrated, that can be used for the study of free gas dispersed in scattering materials [1]. The technique, refered to as GASMAS (Gas in Scattering Media Absorption Spectroscopy), opens up new possibilities for characterization and diagnostics of scattering solids and turbid liquids. The GASMAS project emerged from the interaction of diode-laser gas spectroscopy [2, 3] with optical mammography [4] and differential absorption lidar [5], which all contain elements of the new technique.

Many substances, of both organic and synthetic origin, are porous and contain free gas distributed throughout the material. For instance, wood, fruits, sintered powders, isolating materials, and foams can be considered. Generally, gas can be analyzed *in situ* employing absorption spectroscopy by the use of a sufficiently narrow-banded light source in combination with the Beer-Lambertian law. However, the straightforward application of this method fails for turbid media, since the radiation is heavily scattered and light emerges diffusely.

Gas detection is made possible by the contrast of the narrow absorptive features of the free gas molecules with the slow wavelength dependence of the absorption and scattering cross-sections in solids and liquids. A single-mode probing diode laser is used for the GASMAS measurements, detecting molecular oxygen by wavelength modulation spectroscopy at wavelengths close to 760 nm. Spurious signals from the ambient air can be avoided by placing the laser in a nitrogen-flushed chamber and by guiding the radiation to the sample using a fiber. Temporally resolved measurements employing a picosecond-pulsed diode laser establish the photon history inside the scattering sample, and were consequently used to deduce the imbedded gas concentration [6]. Internal gas pressure can also be measured.

The new possibility to observe free gas in scattering media does not only allow static gas assessment, but also the study of dynamic processes, i.e. how imbedded gas is exchanged with the environment. Feasibility studies were performed on polystyrene foam, where the oxygen penetration into a sample originally subjected to a nitrogen atmosphere was observed to occur with a time constant (1/e) of 44 min. In very small enclosures or bubbles of free gas, additional pressure-induced broadening and shifts of diagnostic value can be expected.

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