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# Multi-wavelength photoacoustic system development for characterisation of aerosols in laboratory and in field campaign

**A. H. Veres** (1), T. Ajtai (1), Á. Mohácsi (2), Z. Bozóki (2), G. Szabó (1)

(1) Department of Optics and Quantum Electronics, University of Szeged, Hungary, (2) Research Group on Laser Physics of the Hungarian Academy of Science, University of Szeged, Hungary

(aniko@titan.physx.u-szeged.hu / Phone: +36 62 544 519)

Atmospheric aerosols have significant effects on global climate, air quality and human health. Man-made activities even as nature and its activities are able to affect climate forcing by influencing the physical and chemical processes of the atmosphere. The composition of the aerosols is crucial in further investigation of their effects. The wavelength dependent aerosol absorption can be used to distinguish aerosols with different sources.

For this purpose a multi-wavelength photoacoustic (PA) system was developed based on a diode-laser pumped, high repetition frequency, Q-switched Nd:YAG laser and its nonlinear wavelength conversions. Wavelength conversions are achieved by focusing the near-infrared light first to a nonlinear LBO crystal and after to second nonlinear CLBO crystal. With this optical solution three different wavelengths were achieved, namely 1064 nm, 532 nm and 266 nm. The distances (in spectroscopic aspect) among them – according to the aim – are sufficient to distinguish the different type of aerosols, as well as the rate contribution of different sources to the total atmospheric aerosol load. In other words, our system has the potential to make difference between soot arises from traffic and from domestic wood burning.

The photoacoustic technique is based on the measuring that portion of absorbed light energy that is first converted into heat through molecular relaxation and then to a pressure wave through thermal expansion. This causes it's very important and useful properties, namely its background-free operation and high selectivity. In a carefully optimized system, negligible PA signal is generated in the absence of a gas component absorbing the incoming light. Consequently, directing each wavelength to separated measuring PA cells, the absorption of the gas sample at previously mentioned wavelengths can be measured.

The gas flow can be switched to go through a particle filter, thus absorption free gas flows through the PA cells. Taking the difference between the PA signals measured directly the environmental sample or its filtered version gave information on the measured absorption of the gas sample with sensitivity of approximately $10^{-5}$ 1/m.

The optical and mechanical stability of the system was achieved by short optical path and post assemblies. Special care was taken to stabilize the temperature of the most critical elements of the system. To fulfil the requirements of field application the whole part of our system was build in a compact and portable box.

The present system was successfully tested and compared with a large set of recently developed or common instrumentation both under the laboratory and field circumstances.

Special emphasis was put on comparing the PA system with other techniques measuring optical absorption.

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