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# Development of inexpensive optical broad- and narrow-band sensors for ecosystem research

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The observation and monitoring of ecosystem processes are great challenges in environmental science, due to the dynamic and complexity of such procedures. To describe and understand biotic and abiotic processes and their interaction it is necessary to acquire multiple parameters, which are influencing the natural regime. Essential issues are: the detection of spatial heterogeneities and scale overlapping procedures in the environment. To overcome these problems an adequate monitoring system should cover a representative area as well as have a sufficient resolution in time and space. Hence, the needed quantity of sensors (depending on the observed parameters or processes) can be enormous. According to these issues, there is a high demand on low-cost sensor technologies (with adequate performances) to realize a delicate monitoring platform. In the case of vegetation processes, one key feature is to characterize photosynthetic activity of the plants in detail. Common investigation methods are based on optical measurements. Here photosynthetically active radiation (PAR) sensors and hyperspectral sensors are in major use. Photosynthetically active radiation (solar radiation from 400 to 700 nanometers) designates the spectral range that photosynthetic organisms are able to use in the process of photosynthesis. PAR sensors enable the detection of the reflected solar light of the vegetation in whole the PAR wave band. The amount of absorption indicates photosynthetic activity of the plant. Hyperspectral sensors observe specific parts of the solar light spectrum and facilitate the determination of the main pigment classes (Chlorophyll, Carotenoid and Anthocyanin). Due to absorption of pigments they producing a specific spectral signature in the visible part of the electromagnetic spectrum (narrow-band peaks). If vegetation is affected by water or nutritional deficience the proportion of light-absorbing pigments is reduced which finally results in an overall reduced light absorption. The resulting spectral signature then differs from usual reflectance patterns and can be used as stress indicator. Hence, reflectances between 550-700 nm are extremely sensitive regarding changing Chlorophyll contents. Both kinds of sensors based on semiconductor technologies whereby the material input can kept on low level. This work presents the development and testing of a practical, rugged, and inexpensive PAR and hyperspectral sensor. The sensors were made from a gallium arsenide phosphide (GaAsP) photodiodes and silicon photodiodes with different interference filters. First results of recorded long term in-situ data and linear regressions (in comparison to commercial products) show extremely high performances (coefficient of determination higher than 0.99) of the PAR sensors simultaneous to the cost cutting.