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Indoor air pollution system based on LED technology

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ABSTRACT

Indoor air quality requirements are a hard constraint for workers' rooms and close locations, and many legislations require frequently measurements for safety. In presence of possible leaks and room climate deterioration, it is required a permanent and online measurements by means of appropriate instrumentation. For hospital rooms, and in particular for surgery rooms, air monitoring of gaseous components is mandatory. In general, there are two main techniques: photo-acoustic spectroscopy (PAS) and chromatography. The first is a portable instrument for quick monitoring even if it is accurate. The latter is not a portable instrument but it is for sensitive and accurate measurements. The paper proposes an architecture of measurements, based on LED spectroscopy for monitoring surgery rooms. In particular, it illustrates the control system based on pulse width modulation. Since the architecture is not PAS and it is not based on chromatography, it could not monitor a large number of pollutants. But conversely, it would be able to measure with high accuracy a small number of chemical species included in pollutants. We only report a deep analysis and experimental activities of control systems.

1. Introduction

Anthropogenic activities have been affecting not only the quality of atmosphere [1,2] but also indoor building air characteristics [3,4]. Some activities are carried out in close facilities; in particular, surgery room inner "atmosphere" is an of online monitoring because small volumes of liquid anesthetic agents such as halothane, enflurane, isoflurane, desflurane, and sevoflurane evaporate readily at normal room temperatures, and may dissipate before any attempts to clean up or collect the liquid are initiated. Incidental releases of liquid anesthetic agents where the substance can be absorbed, neutralized, or otherwise controlled at the time of release can be performed by employees in the immediate release area. However, when large spills occur, such as when one or more bottles of a liquid agent break, specific cleaning and containment procedures are necessary and appropriate disposal is required. Because of the volatility of liquid anesthetics, rapid removal by suctioning is the preferred method for cleaning up spills. Other gases can be also detected in hospital facilities beyond from operation theaters, for example VOC. Volatile organic compounds (VOCs) represent a broad range of odorous and harmful substances that include olefins, aromatics, hydrocarbons and various oxygen-, nitrogen-, sulfur-, and halogen containing molecules. Their impacts on human health cause many effects that range from a simple nuisance to a serious hazard, and legislations have been approved to reduce their emissions. Emission of VOCs come from, in a virtual way, all industrial sources in a form or another. Many of organic compounds with less than 12 carbon atoms are VOCs [5]. Strictly speaking, VOCs do not include particulate matter. Some aerosols are formed from condensed droplets of VOCs, however, and their treatment can involve specific methods in order to determine their amount. Further elements to be taken into account are the concentration of CO_2 and sevoflurane which can be considered as an indirect index of environmental pollution. National and European rules often encompass the

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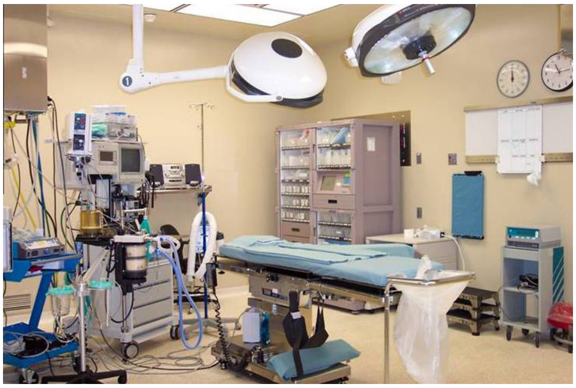

Fig. 1. Surgery room.

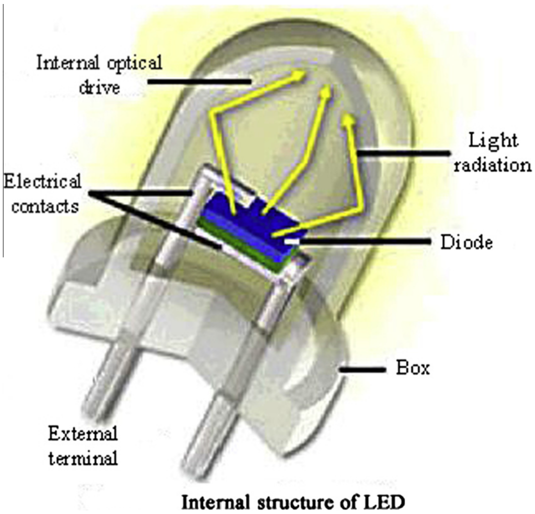

Fig. 3. LED device.

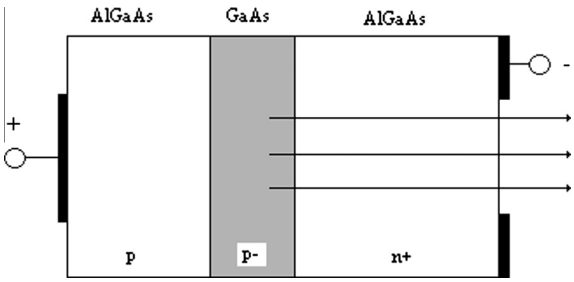

Fig. 4. Heterojunction structure.

american NIOSH (National Institute for Occupational Safety and Health) regulations and maximum concentrations; for instance, N_2O = 25 ppm for general surgery rooms, N_2O = 50 ppm for dental surgery rooms, and halogenated gases = 2 ppm as ceiling value. Consequently, amid growing concerns [6,7], a multi-gas monitor is a key issue for health protection, in order to assess the values of concentrations. As an example, Fig. 1 shows an operation theatre and Fig. 2 illustrates biomedical gas plan and grid which technological structure has been verified and tested by one of the co-authors; in fact Fig. 2a depicts all gas tanks used for supplying surgery rooms and patient rooms. In the center, we can see the control panel where online measurement of gas flow is performed. In the right side, a testing is illustrated for verifying gas leakage when all valves are closed.

2. LED sources and sensors

A brief and salient literature on specific LED-based applications is described in the present paragraph. By far, the majority of LED applications encompass absorbance measurements in flow-through cells. Hauser and Chiang are among the most active in the use of LEDs as spectroscopic sources and were the first to report the use of a blue LED as a spectroscopic source as these devices first became available [8]. Early blue LEDs were

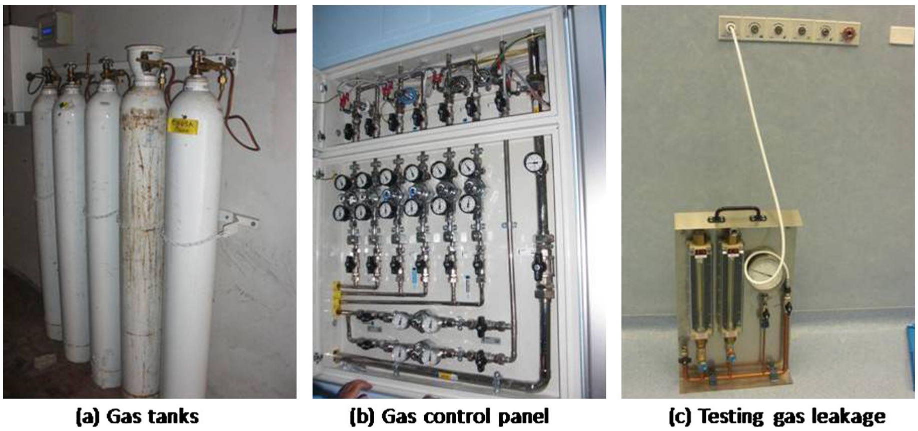

Fig. 2. Gas plan and grid.