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# FIBRE OPTIC SENSORS FOR COAL MINE HAZARD DETECTION

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## Abstract

A number of health and safety hazards present in underground coal mines, which include methane gas explosion, coal combustion, rock roof collapse, and flooding etc. Methane gas and coal combustion have been two major hazards, which resulted in most of the heavy casualties and economic losses. Conventional catalytic methane gas sensors suffer from poor accuracy and cumbersome maintenance, which is the bottleneck of methane hazard prevention. Coal mine combustion monitoring has been relying on gas tubing bundles system, which suffers from long time delay and poor reliability. Semiconductor laser diode methane gas sensors have been developed which has low power consumption, 0-100% full detection range and high accuracy, and no need of recalibration. Fibre optic Raman distributed sensors have been deployed in coal mine goaf and successfully detected combustion hazard in early phase. The FOS-based mine hazard detection system offers unique advantages of intrinsic safety, multi-location and multi-parameter monitoring. The application of FOS on monitoring of methane, coal combustion, micro-seismic and equipment condition are described, future trend of research in this area is also discussed.

**Keywords:** Fiber optic sensor, coal mine, methane, seismic, hazard detection

## 1. Introduction

Coal is the primary energy source of many countries in the world. Annual coal production has been around 8 billion tons in recent years as shown in Fig.1 [1]. In China, coal provides around 65% of the total energy and annual coal production in 2016 was around 3.7 billion tons. Over 95% of Chinese coal mines are underground mines. The depth of underground coal mines increases by an average of around 10 m per year, with the deepest mine reaching 1400 m below the ground level. The increase in mining depth significantly increases safety hazards such as large strata pressure and rock or methane burst. Over 55% of the Chinese coal mines are gassy, hence methane is big safety hazard. The casualty figures between 2001 and 2016 are shown in Fig. 2.

Coal mine hazards consists of the following major types, (i) methane gas outburst and explosion; (ii) roof fall and coal and rock outburst; (iii) coal spontaneous combustion; (iv) water flooding and (v) hazards caused by electrical machinery failures. Around 80% of the large casualty accidents, where more than 10 people died in a single incident have been caused by methane explosion. Therefore, major effort has been made on methane monitoring and control. Thanks to the coal mine methane gas monitoring systems, which have been compulsively implemented by the government work safety

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