Prospects of using Carbon Film Sensors for Gas Contamination Monitoring in Coal Mines and Drilling Rigs

Mykhaylo Matviykiv, Vasyl Teslyuk, Taras Matviykiv

Abstract - **This paper presents the analysis of possible carbon thin-film sorbents using for the mine-gas sensors manufacturing.**

Keywords – **carbon film sensor, coal mines, drilling rigs.**

I. INTRODUCTION

While passing the coal layers and drilling operations it is often passed through inflammable and highly explosive gas. Methane (CH_4) is the man component of this gas. Existing methods of gas contamination monitoring sometimes does not bring the expected result of timely detection. As evidence we can see quite frequent press and television reports about coal mine gas blast and inflammation. Regarding this a need for advance, portable and reliable methods for gas contamination control inside coal mines and drilling rigs occurs.

II. MAIN PART

Our analysis of available information on the topic of publication shows that today the most common material for contamination control device sensors in coal mines and drilling rigs is tin dioxide (SnO_2), alloyed by elements such as Pt, Cu, Pd, Ni, which selectively adsorbs methane - the main component of coal mines gas. The activated charcoal also could be used for such kind of absorption.

Activated charcoal is obtained from heating the wood without oxygen access. Thanks to porous structure it has very high absorption capability. To increase the absorption capability charcoal is additionally activated. One of the activation methods is a treatment with overheated water steam for removing of resinous substances. Resinous substances are formed inside of wood porous while destructive distillation process.

Our researches (Fig. 1) show that carbon films could be used as selective methane sorbent, instead of porous activated charcoal. Carbon films has slightly lower adsorption ability comparing to activated charcoal, but constructively and technologically they are more compatible with micro electrical construction and technology. This brings possibility to manufacture small-size sensors devices for gas contamination monitoring.

Mykhaylo Matviykiv - Lviv Polytechnic National University,
S. Bandery Str., 12, Lviv, 79013, UKRAINE,
e-mail: matviykiv@polynet.lviv.ua

Considering carbon refractoriness (T = 375°C) for carbon films production should be used such methods, which is used for refractory materials preparation. Such methods include pyrolytic decomposition of saturated hydrocarbon (C_nH_{2n+2}), laser or electron-beam evaporation, ion-Plasma or magnetron spraying.

In order to obtain high sorption capacity, the films should be grainy and porous. Therefore films forming modes and substrate must correspond to this condition. Rough surface provide high coating graining and porosity.

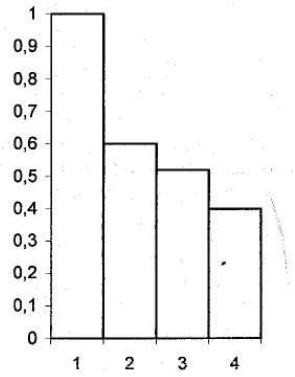

Fig.1 Sorption capacity of methane, carbon sorbents: 1 – activated charcoal; 2, 3, 4 - film obtained at low-temperature which is obtained by pyrolis (< 900 C) of heptanes vapors (C_7H_{16}), electron beam evaporation of graphite, ion-plasma spraying graphite target.

\

Accordingly has to be chosen the mode of deposition. In pyrolytic decomposition of heptane C_7H_{l6} —> $7C + 8H_2$ grainy and porous film will be formed at pyrolysis temperatures lower than 900°C. In electron-beam evaporation and ion-plasma spraying coarse porous film are formed at high substrate temperature (T> 300°C).

Films which are obtained by ion-plasma spraying method have some lower sorption ability comparing to films, obtained by thermal evaporation method because of condensation charge mechanism presents and presents of ion bombardment of condensate.

III. CONCLUSION

1. Pyrolytic and sputtering porous carbon films are suitable to be used as small selective methane sensors.
2. For transforming adsorption into the signal a chromatography, resistance, capacitance or resonance methods could be used.