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Selective hydrogen sensor for application working in methane atmosphere

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Introduction

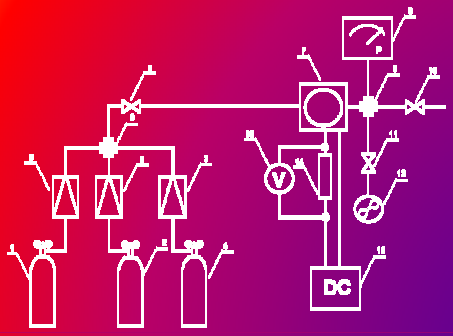
For some purposes it is necessary to detect hydrogen in mixtures with other gases, e.g. methane. Especially this selectivity is important in such areas as defence systems, chemical industry or mining. We present selective hydrogen sensor for application working in atmosphere containing methane. Our sensor is based on nanocomposite C-Pd films.

C-Pd films are promising materials for hydrogen sensor applications. It is connected with high surface area of these films and highly selective hydrogen absorption properties of palladium nanocrystals. The sensing mechanism of such films is based on resistance changes of palladium in the presence of hydrogen.

Experimental

The nanocomposite C-Pd films were obtained by Physical Vapour Deposition (PVD) method on alundum substrate. In PVD process two separated sources containing fullerene C_{60} and palladium acetate $Pd(OAc)_2$ were used. The morphology and topography of these films were characterized using SEM and TEM techniques. Sensing measurements were performed in gas containing different hydrogen concentrations in N_2/CH_4 mixture. For comparison the changes of films response for H_2/N_2 mixture were also measured.

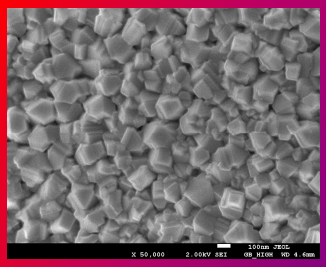
Set-up for sensing measurements



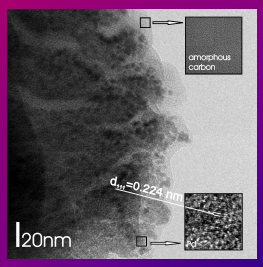
1, 2, 4 – gas bottles
3 – mass flow controllers
5 – gas mixer
6, 10, 11 – valves
7 – measurement chamber
8 – pressure meter
9 – four-way splitter
12 – vacuum pump
13 – voltmeter
14 – reference resistor
15 – voltage source

Characterization of C-Pd films

SEM

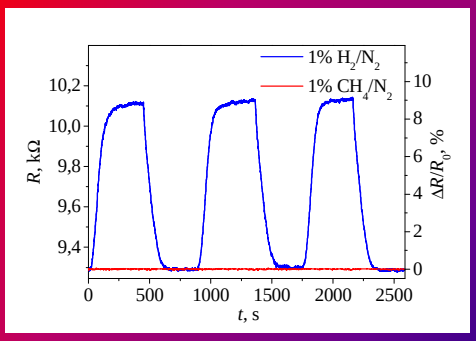


TEM



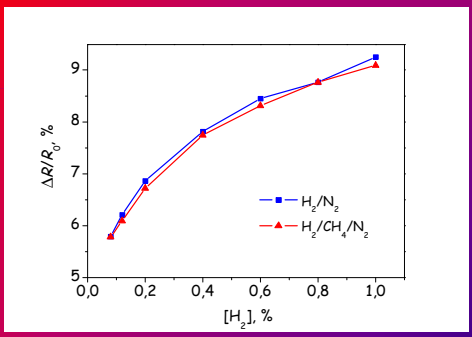
C-Pd films are composed of carbonaceous-palladium grains containing many palladium crystallites placed in fullerite and amorphous carbon matrix.

Sensitivity to H_2 and CH_4



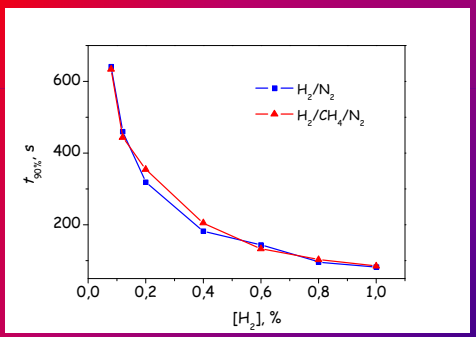
The introduction of hydrogen causes an increase of C-Pd films resistance due to formation of palladium hydride (PdH_x). However, the films are insensitive to methane presence.

Sensitivity to H_2 in CH_4 presence



The presence of methane in the surrounding atmosphere does not affect C-Pd films sensitivity towards hydrogen.

Response time to H_2 in CH_4 presence



The presence of methane gas does not influence kinetics of hydrogen adsorption on palladium surface, and then does not limit further interaction resulting in palladium hydride formation.

Conclusions

- Palladium nanograins placed in carbonaceous matrix are active in hydrogen sensing and are insensitive towards methane gas.
- The presence of methane in the surrounding atmosphere affects neither films sensitivity nor the rate of response to hydrogen.
- The obtained C-Pd films can be used as active layers of hydrogen sensors working in methane presence.

INNOVATIVE ECONOMY
NATIONAL COHESION STRATEGY

Acknowledgements

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