NANOCOMPOSITE CARBONACEOUS-PALLADIUM THIN FILMS FOR AMMONIA SENSING

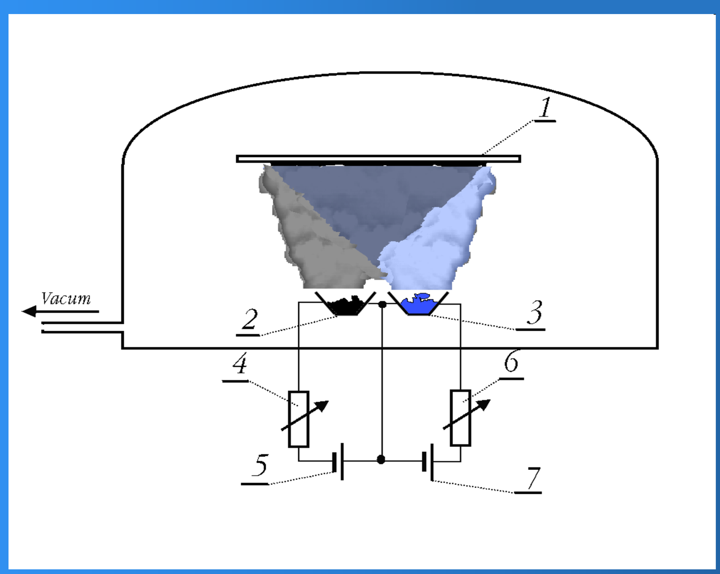
Sławomir Krawczyk*, Anna Kamińska, Mirosław Kozłowski, Joanna Radomska, Elżbieta Czerwosz

Tele and Radio Research Institute, Ratuszowa 11, 03-450 Warsaw, Poland

Motivation

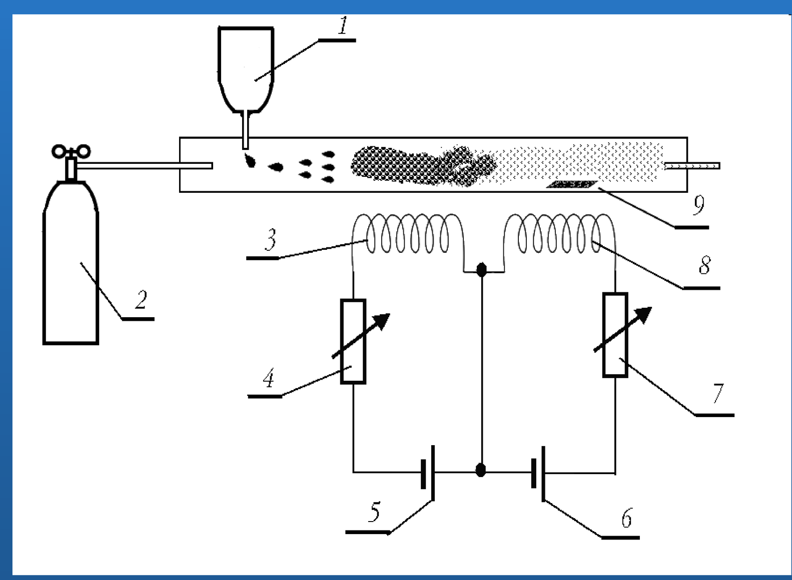
Ammonia is widely used gas that is dangerous and harmful. An important issue is its detection. The most commonly used material for the ammonia sensors is zinc oxide. Due to the necessity of using the heating elements for proper operation of sensors, they have high power consumption. Nanocomposite carbonaceous-palladium films which are produced in Tele and Radio Research Institute, are sensitive to ammonia and do not require heating, therefore they are a promising low cost material for ammonia sensors.

Physical Vapor Deposition



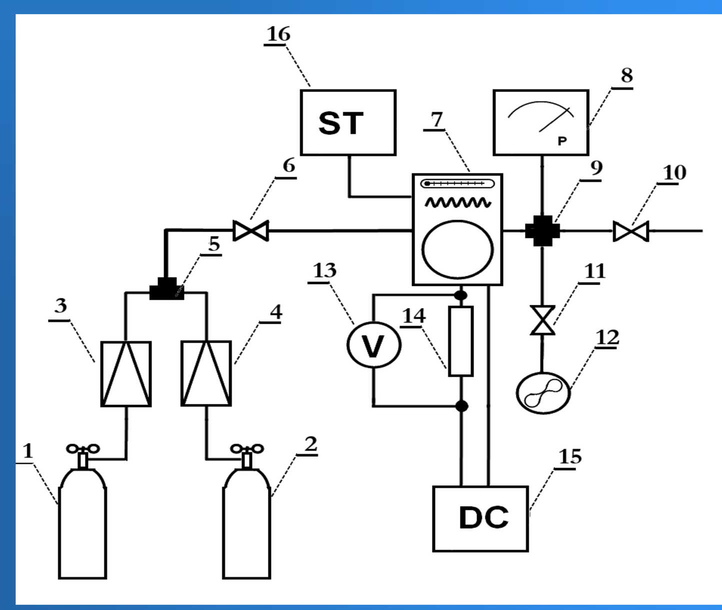
1 – sample 2 – heater with source of C_{60}, 3 – heater with source of $Pd(OAc)_2$,4 – control resistor 1, 5 - power supply 1, 6 - control resistor 2, 7 - power supply 2.

Chemical Vapor Deposition



1 – xylene bottle,2 – argon bottle, 3 – heater 1,4 – control resistor 1, 5 - power supply 1, 6 - power supply 2,7 - control resistor 2, 8 - heater 2, 9 - sample

Experimental setup



1, 2 - gas bottles, 3, 4 - 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,16- temperature controller

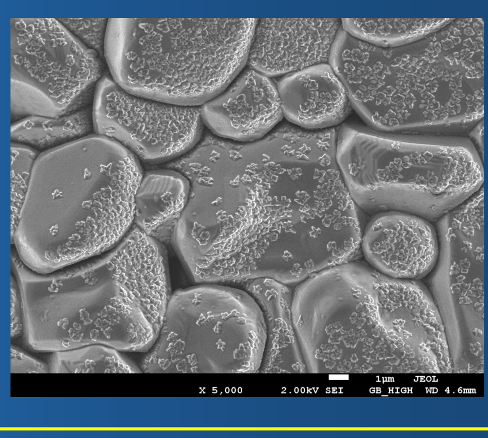
Parameters of PVD process

All PVD processes were performed at the same conditions beside of sources-substrate distance (sources temperature and process duration time)

Process nº	Distance [mm]
P1	55,49
P2	54,27
P3	58,07

SEM micrograph after PVD process | Parameters of CVD process | SEM micrograph after CVD process | Changes in C-Pd film electrical properties under the influence of amonia

P1

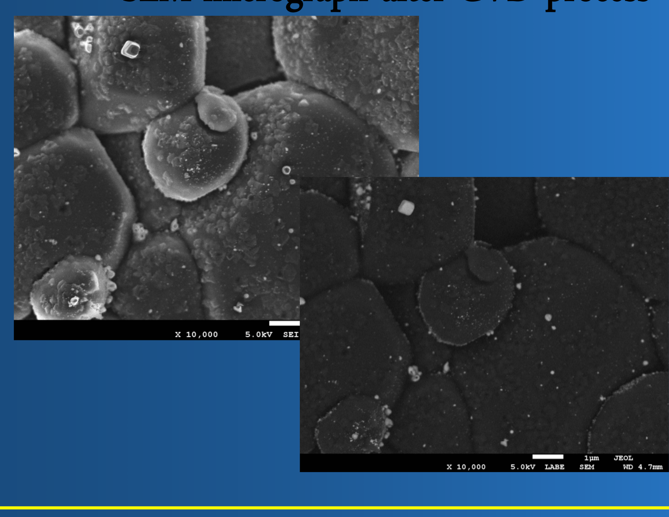


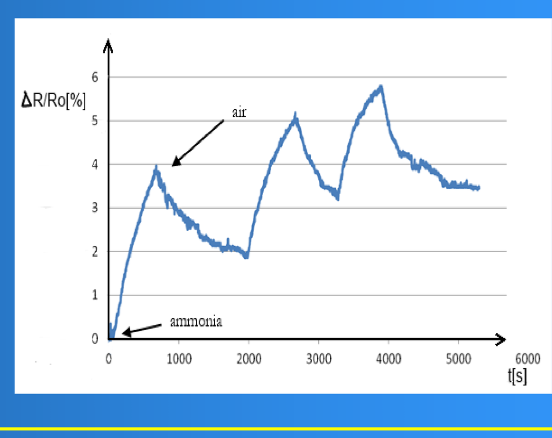
T1 = 180 °C

T_2 = 550 °C

t = 10 min

C_8H_{10} 3ml/min





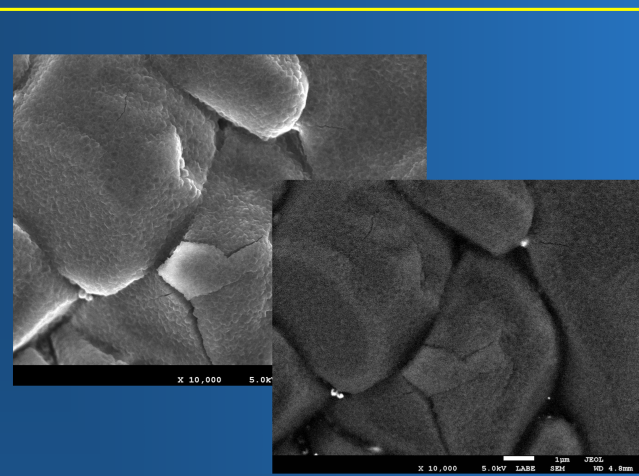
P2

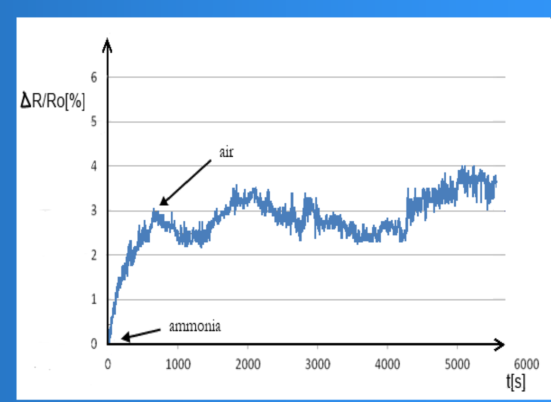
T1 = 180 °C

T_2 = 650 °C

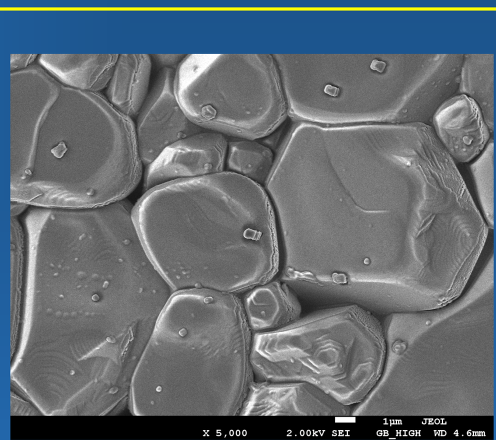
t = 10 min

C_8H_{10} 3ml/min





P3

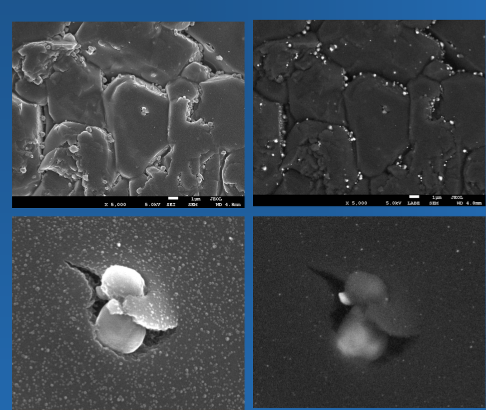


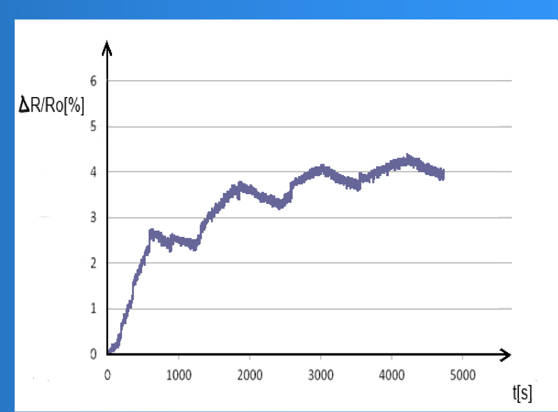
T1 = 180 °C

T_2 = 750 °C

t = 10 min

C_8H_{10} 3ml/min





Conclusions

Nanocomposite carbonaceous-palladium (C-Pd) films, which were made in Tele and Radio Research Institute are promising materials for ammonia sensor applications. Films were characterized by SEM (after PVD and PVD/CVD process). Sensing properties on ammonia for all these films were also measured.

Our SEM investigations of initial film obtained from PVD process reflect substrate surface's shape and are composed of angular grains of few hundred nm in size. Microscopically studies of PVD/CVD films show that topography and morphology of the film strongly depends on the temperature of CVD process. The best sensing properties were obtained for film where Pd nanograins form conducting paths on the edge of big grains of substrate covered with C-Pd film. The worst sensing properties were observed for film without such conducting paths. In the film annealed at 750 °C Pd nanograins were surrounded with carbon shell what impeded hydrogen desorption process.

INNOVATIVE ECONOMY
NATIONAL COHESION STRATEGY

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