

SMART MATERIALS FOR HYDROGEN and RENEWABLE ENERGY

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COMPOUNDS SENSOR FOR APPLICATIONS IN ABJORE NORMATIVE CONDITIONS IN ABJORE NORMATIVE CONDITIO

TOPOGRAPHY AND STRUCTURE OF HYDROGEN SENSITIVE C-Pd FILMS

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INTRODUCTION

Carbonaceous-palladium (C-Pd) films are sensitive for hydrogen and can be used as the hydrogen detector because it has great affinity towards H₂ absorption. Hydrogen atoms have ability to occupy the octahedral interstitial positions within Pd's *fcc* lattice. The incorporation of hydrogen atoms results in the formation of palladium hydride.

Hydrogen sensor designs rely on the fact that palladium hydride's electrical resistance is larger compared to pure bulk palladium resistance. The same effect is supposed to have a place in nanostructures of Pd. Absorption of hydrogen in C-Pd films is accompanied by a measurable increase in electrical resistance. In case of Pd nanoparticles, when the hydride is formed, Pd grains swell and in the process of expanding, some of them form new electrical connections with their neighbors. This is also connected with the structure and the topography of such films.

In this work the influence of topography and structure on electrical properties of C-Pd films was investigated.

EXPERIMENTAL

C-Pd films were obtained by Physical Vapor Deposition (PVD) method. PVD method relies on film deposition from two separate sources containing fullerene C_{60} and palladium acetate $Pd(C_2H_3O_2)_2$ under dynamic pressure 10^{-5} mbar.

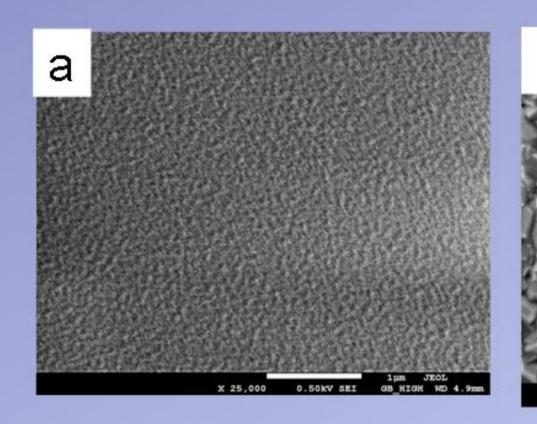
Sample no	I _C [A]	I _{Pd} [A]	d [mm]	t [min]	Substrate	R [kΩ]	
1	2.1	1.1	69	8		1000	
2	2.1	1.2	54	8	Si/SiO ₂	30000	
3	2.1	1.2	54	10		0.0003	

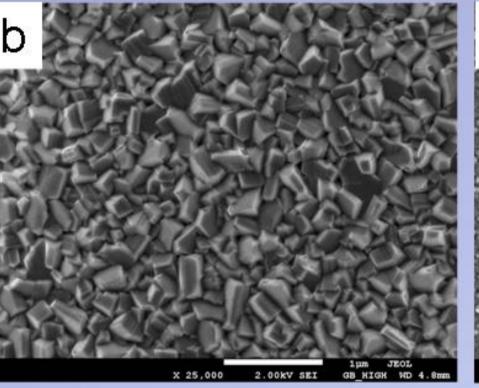
 $I_{\rm C}$, $I_{\rm Pd}$ - intensity of current through sources, d- distance between substrate and sources, t- time process, R - resistance

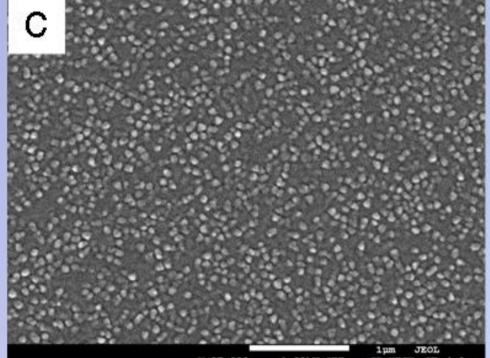
RESULTS

We used scanning electron microscopy (SEM), atomic force microscopy (AFM), transmission electron microscopy (TEM) and Fourier Transformed Infrared absorption spectroscopy (FTIR) to characterize topography and structure of C-Pd films.

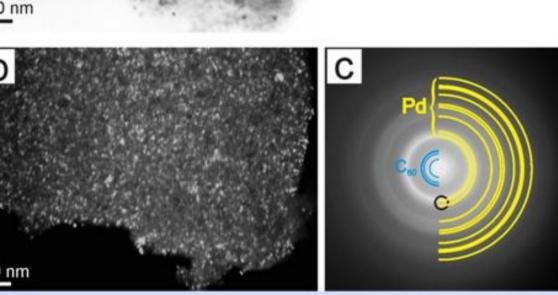
From TEM studies we found that Pd nanograins diameters are typically between 2 and 10 nm.







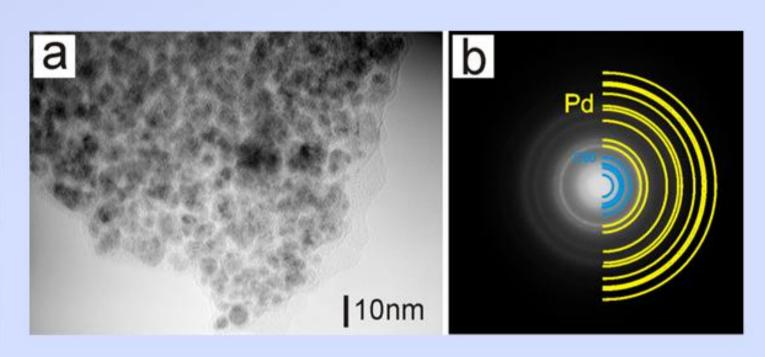
a <u>50 nm</u> C



TEM images of sample 1 a) in bright

field, b) in dark field, c) diffraction

pattern for C-Pd films

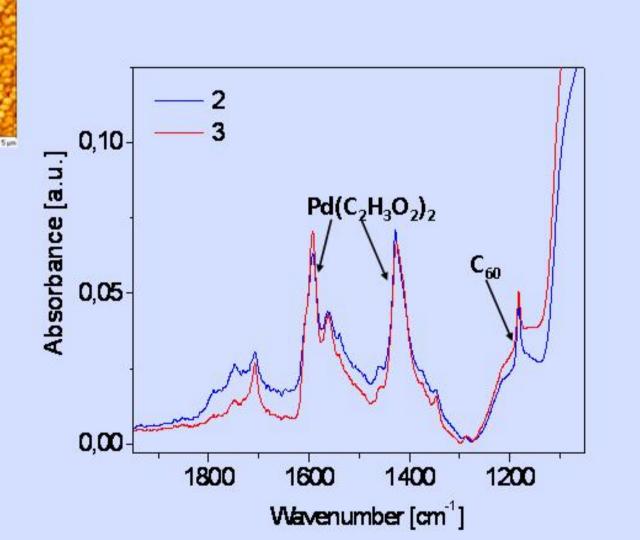


TEM images of sample 2 in bright field with diffraction pattern

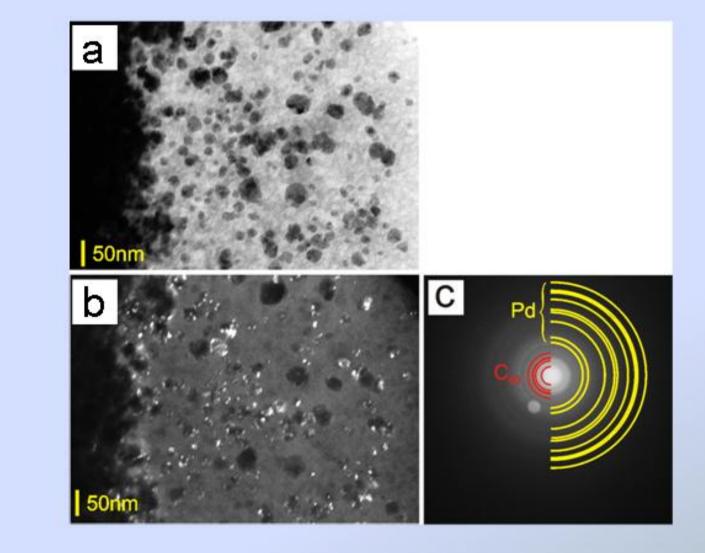
SEM images of sample 1 a), 2 b), 3 c)

AFM images of sample 1 a), 2 b), 3 c)

Sample	Average		
no	roughness [nm]		
1	12.38		
2	17.46		
3	4.18		



FTIR spectra of sample 2 and 3



TEM images of film 3 a) in bright field, b) in dark field, c) diffraction pattern

CONCLUSIONS

C-Pd films were obtained by PVD method with different process parameters. The distance d and time process were changed that affects on film's resistance. TEM images show that C-Pd films consist of Pd nanoparticles and fullerene C₆₀ grains. Pd nanograins are of size of few nm and they are placed in carbonaceous matrix. They are not visible in SEM images. Topography of C-Pd films is connected to shape of carbonaceous grains. The rectangular shape of these grains depends on fullerene content in the grain. In case when film contains other form of carbon grains are more oval and surface becomes more flat.



