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TEM AND Cl INVESTIGATIONS OF Pd NANOGRAINS INCLUDED IN CARBONACEOUS FILM

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INTRODUCTION

The problem of the hydrogen molecules detection and also hydrocarbons with sufficient sensitivity is very important. The future of aerospace, automobile and energy sectors will revolve around hydrogen fuel. It becomes really important to control and monitor these gases, as there is a huge risk of damage to property and human lives if a leak occurs. Certain gases can be toxic for humans, or corrosive gases or else explosive. So we need sensors that can continuously and effectively detect gases. In Tele - & Radio Research Institute such films, containing palladium nanograins were synthesized and can be applied as active layer in hydrogen detector.

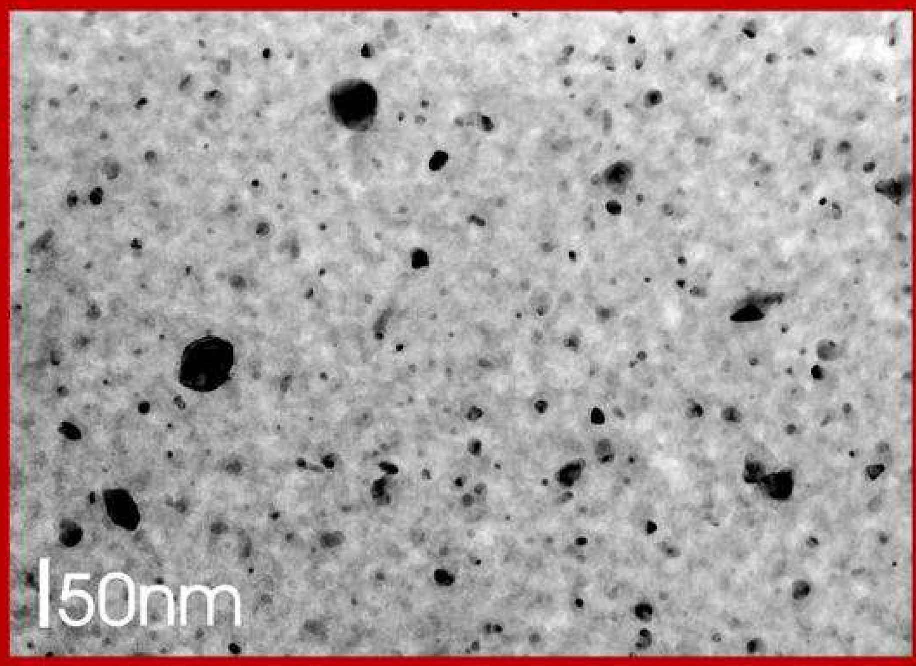


Fig.1. TEM image of the CVD sample.

EXPERIMENTAL

In PVD method multiphase carbonaceous nano-Pd films were deposited on ceramic substrates under the dynamic pressure of 10^{-5} mbar. Two separated sources were used: one containing fullerene C_{60} powder (99,9%) and second with palladium acetate $Pd(C_2H_3O_2)_2$. During the synthesis process the temperature of the substrates was ~ 100ºC and growing time was 8 min. The film originating from the PVD process was modified in the CVD method due to temperature and xylene decomposition over the film surface. Finally a carbon nanoporous film like foam structure containing Pd nanograins was obtained. More information about this process [1] [2]. The CVD film are presented in Fig.1.

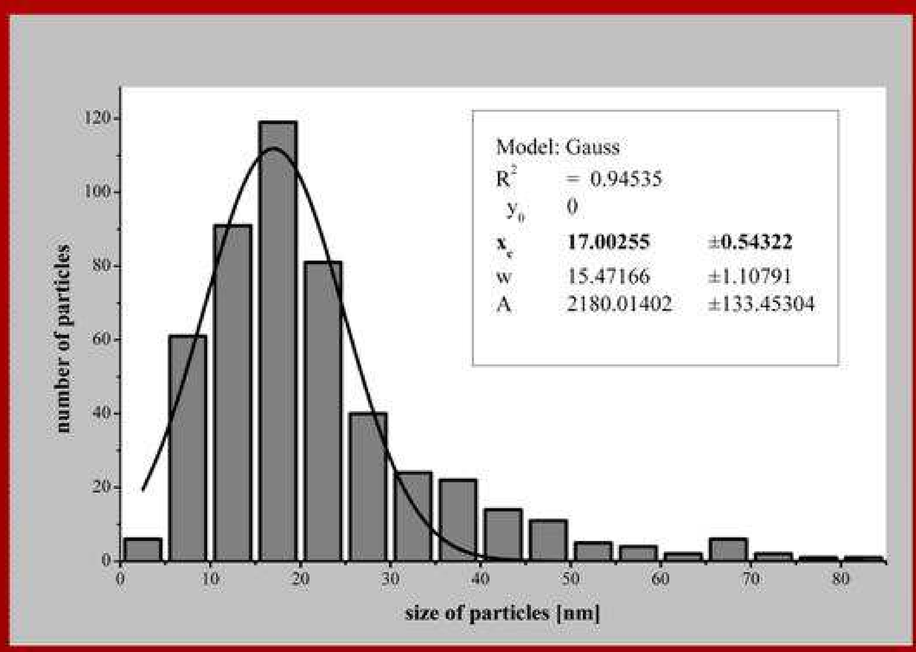


Fig.2. Histogram of the size distribution of the Pd nanoparticles.

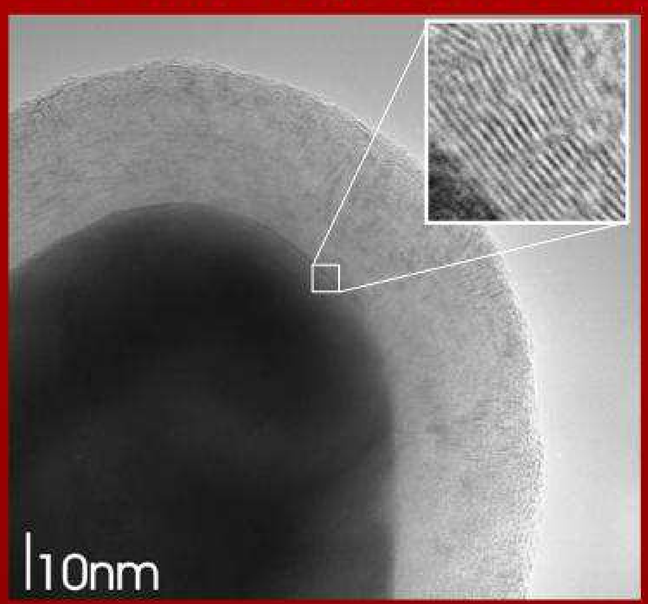


Fig.3. Pd particle with graphite shell

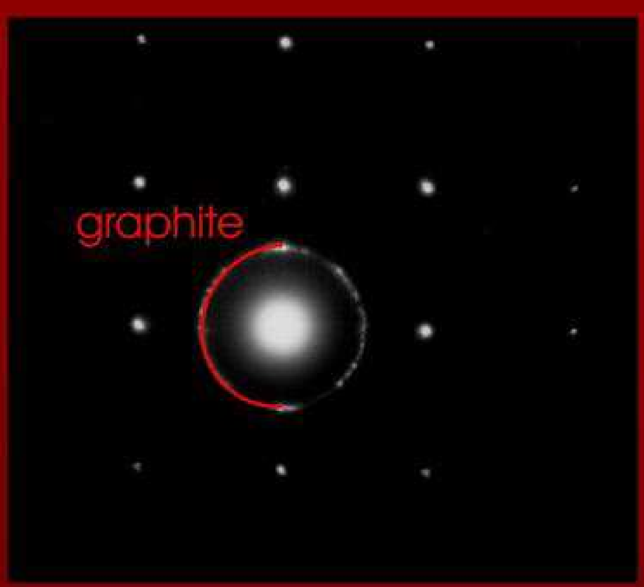


Fig.4. SAED from Pd particle with shell

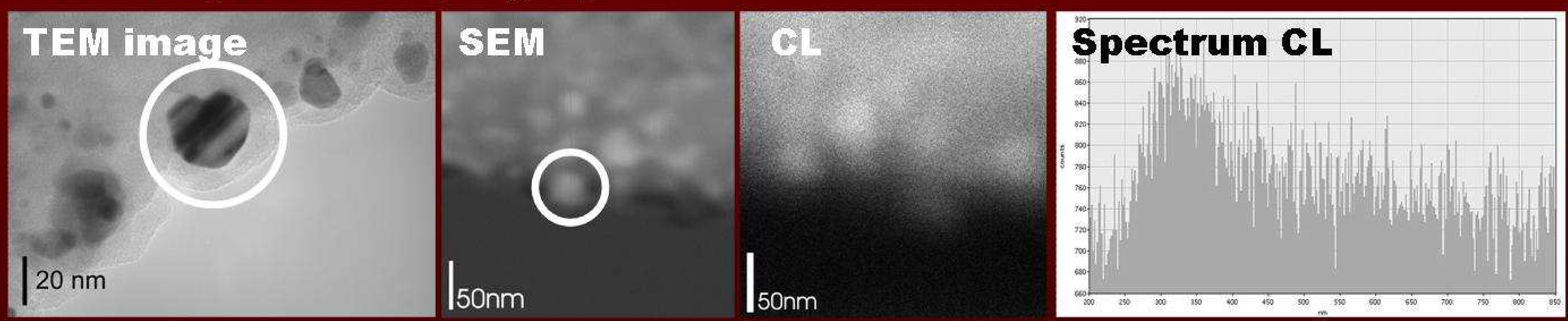
RESULTS

Carbonaceous films obtained in the CVD process and containing Pd nanocrystalites were studied by TEM and CL. The size distribution of Pd nanocrystallites for CVD film is presented in Fig.2. Our observatoins showed that big (more than 40 nm) nanoparticles had a graphite shell. The shell thickness dependent on dimensions of the Pd nanograin and grow with the size of the Pd nanograins. The shell on Pd nanograin is showed in Fig.3. and on on the fig 4. selected ares electron diffraction pattern from this structure with a marked ring of grapite. We carried out connected examinations by TEM and CL methods. For our research we chose two kind particles: with and without a graphite shell. The particles were marked after TEM investigation and passed on to CL for further research. Noted that particle with shell were optically active. In Fig.5. we presents a series Image for naked particle. On first image there is showed TEM image with particle that were chosen to further investigations. Second picture – the same particle in scanning microscopy, next, image in CL and the last one – spectrum collected from that particle. We do not observe any significant optical activity. In the second case we investigate a particle with a graphite shell. In the Fig.6. we see image in a similar situation from Fig.5. This time a single particle were optically active – image CL with strong visible particle and we observed strong peaks in CL spectrum at 525 nm.

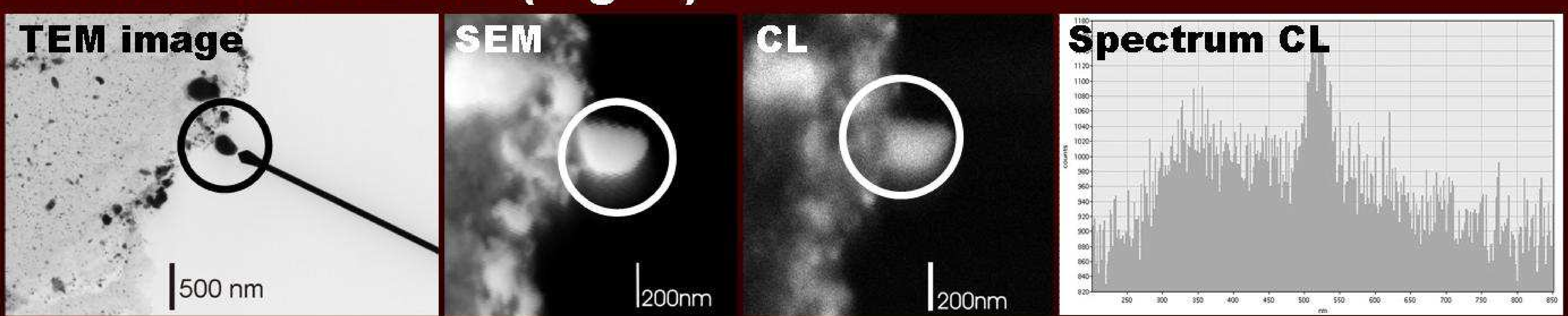
PLANS FOR THE FUTURE

The physical effects of lightning Pd nanograins with shell is not well know. It seems that Pd nanograins needs a full graphite shell to be active optically. In the future we want check whether the energy of emission depends on the size of the Pd nanograins and the thickness of shells. It will be helpful to getting to know the phenomena of lightning. Probably surface plasmons (SPR) are best mechanism explains such phenomena.

Naked particle (Fig.5)



Particle with shell (Fig. 6)



CONCLUSIONS

TEM and CL connected investigation of the single nanoparticles showed an interesting phenomenon is which optical activity only nanograins with a graphite shell. Energy emission is 2,36 eV and it is part of visible light spectrum (green). So far in this range spectrum were observed only nanorods and Ag nanospheres [3]. Spectral range for particles with shells (so far) end on value 590 nm.

[1] E. Kowalska, E. Czerwosz, J. Radomska „METODA SYNTEZY NANOPOROWATYCH MATERIAŁÓW WĘGLOWO - PALLADOWYCH” Elektronika 1/2009
[2] Sposób otrzymywania nanopianki węglowej zawierajacej nanokrystality metalu E. Czerwosz, E. Kowalska, J. Radomska, H. Wronka zgłoszenie patentowe nr P384591 z dnia 03.03.2008r.
[3] S. Lal et al. Nature Photonics 1 2007 641-648

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