Moscow State University, department of materials science

Optical study of tin oxide nanocrystals

Zhurbina Irina

Outlook

1. Introduction
2. Samples
3. Methods of investigation
4. Experimental results and discussion
5. Conclusions

Introduction

Tin oxide (SnO_2) is one of the most prevalent semiconductor materials used for gas sensors.

Nanocrystalline tin oxide exhibit larger surface area, what improves gas sensing sensitivity.

Advantages of tin oxide gas detectors:

•Stability in air

•Simplicity of preparation

•Wide range of detected gases (CH_4, CO, CO_2, H_2S, NO_2, H_2, O_2, NH_3)

•Low cost

<u>The aim</u> of our work is to investigate the influence of nanocrystal sizes and surface treatment on optical properties of tin oxide nanocrystals.

Samples

Powders of tin oxide nanoparticles have been prepared by using two modifications of the wet chemical synthesis as it is shown in figure 1.

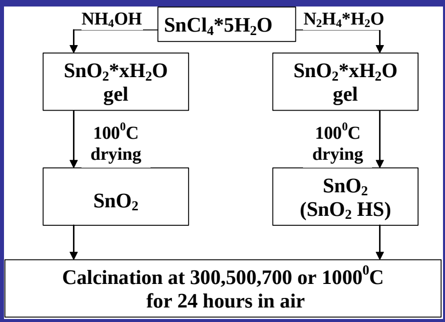


fig1. Methods of samples preparation

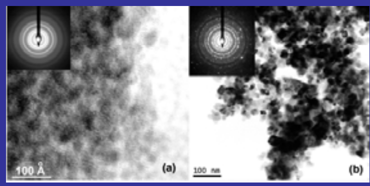


fig 2. TEM images of SnO_2 annealed at 300^0C (a) and 700^0C (b)

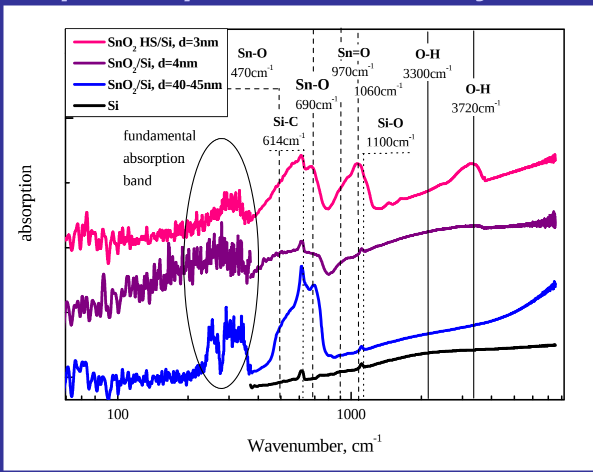
Average size of tin oxide nanocrystals varies from 3 to 45 nm according to transmission electron microscopy (TEM) (fig. 2) and X-ray diffraction data.

Methods of investigation

Infrared spectroscopy: IR spectra were measured by using IR-Fourier spectrometer Bruker IFS 66v/S in vacuum 0.002mBar at room temperature.

Raman spectroscopy and **photoluminescence** : Experimental spectra were obtained by using Microraman spectrometer LabRam HR800 Horiba Jobin Yvon at room temperature in air.

IR absorption spectra of nanocrystalline SnO_2



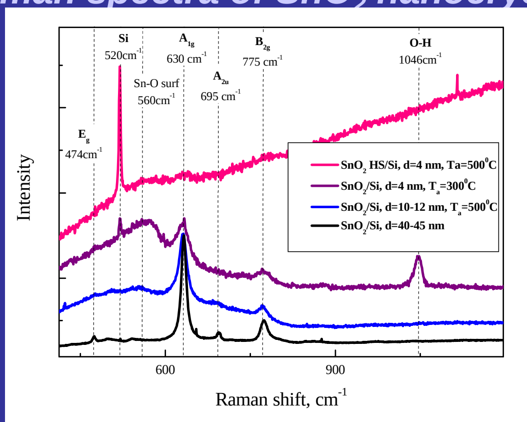
Size effect :

- disorder increasing
- local surface impact growth

Surface treatment effect :

- water molecules adsorption enhancing
- specific surface area raising

Raman spectra of SnO_2 nanocrystalls



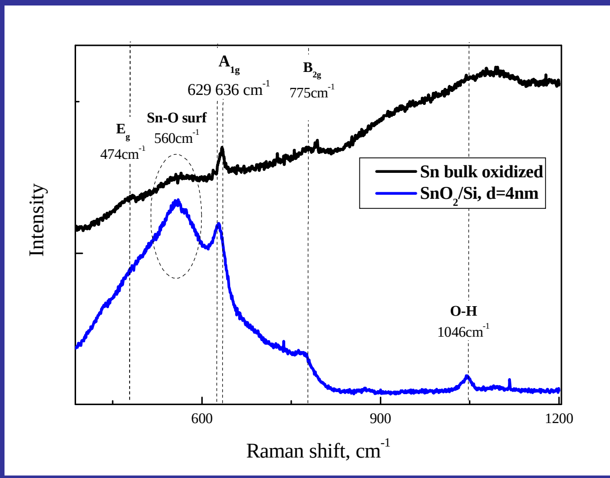
Size effect:

- crystalline phase reducing
- water molecules adsorption growth
- surface impact enhancing

Surface treatment effect :

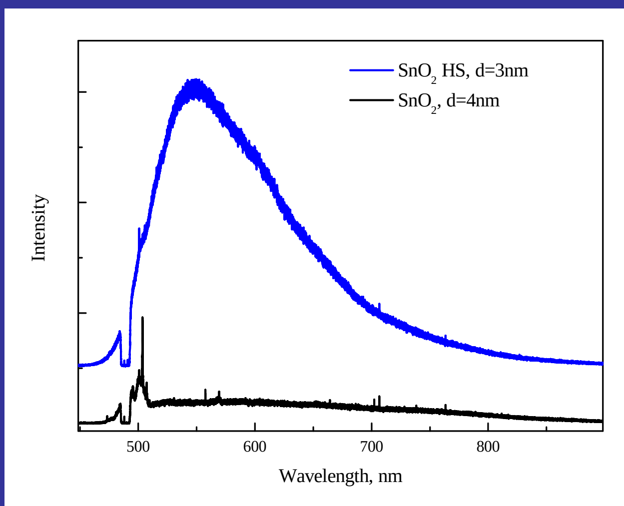
- surface states changing

Raman spectra of SnO_2 nanocrystals and bulk oxidized Sn



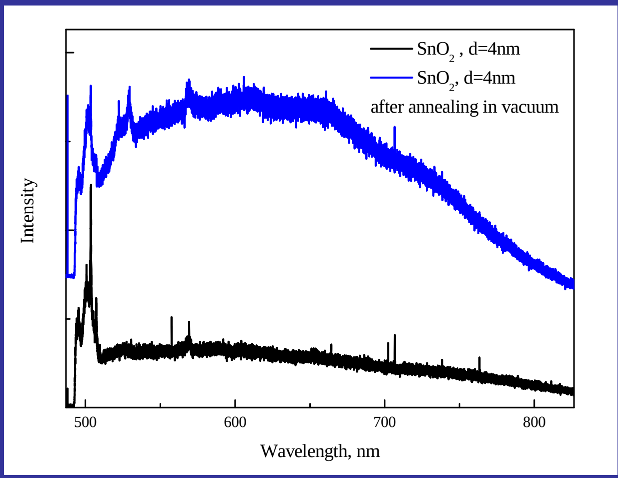
A wide maximum at 560 cm^{-1} corresponds to local surface vibrations

Photoluminescence of SnO_2 nanocrystals



Monohydrate hydrazine treatment leads to a significant increase of the density of defect states.

Photoluminescence of SnO_2 nanocrystals



Thermal annealing in vacuum leads to the growth of the surface defect concentration.

Conclusions

1. Raman and IR spectroscopy are relevant tools for surface composition analysis

2. According to Raman spectroscopy, IR absorption and photoluminescence data the surface treatment and size effect influence strongly on the surface defects in tin oxide nanoparticles:

- Surface impact is rapidly increased under particles size decreasing
- Water molecules adsorption is significantly enhanced after monohydrate hydrazine treatment
- Surface defect concentration is growing after thermal annealing in vacuum or monohydrate hydrazine treatment

Acknowledgements

1. Prof. V.U. Timoshenko

2. Prof. A.M. Gaskov,

assoc. prof. M.N. Rumyantseva