

European Network on New Sensing Technologies for Air Pollution Control and Environmental Sustainability - *EuNetAir*

COST Action TD1105

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organized by VINCA Institute and co-organized by Public Health Institute of Belgrade

hosted by Faculty of Mechanical Engineering, University of Belgrade

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Gas Sensing Properties of Pd Nanoparticles on TiO₂ Nanorods

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cost
EUROPEAN COOPERATION IN SCIENCE AND TECHNOLOGY



1. Introduction

- Main Research Area
- Motivation of This Work

2. Experimental

- Fabrication of TiO₂ nanorods
- Decoration of Pd nanoparticles on TiO₂ nanorods
- Sensor Device

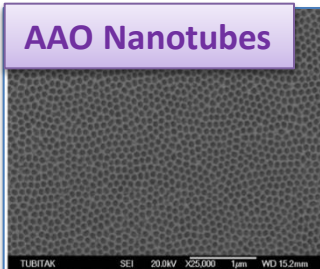
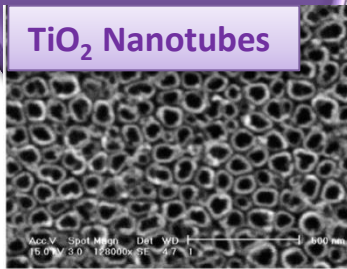
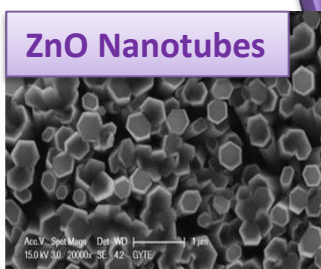
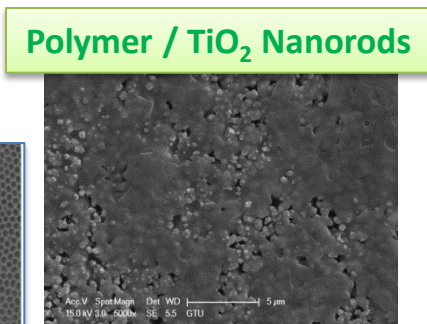
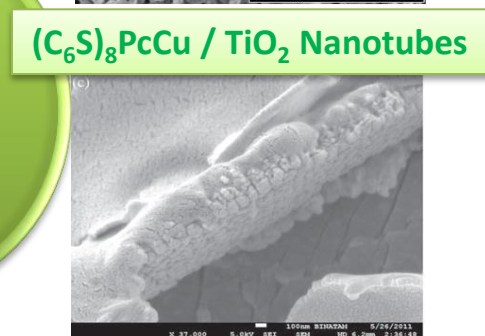
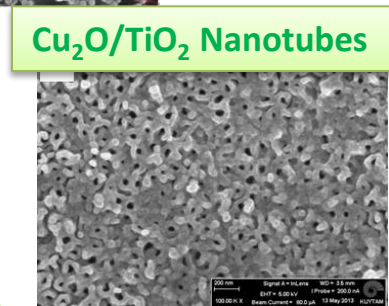
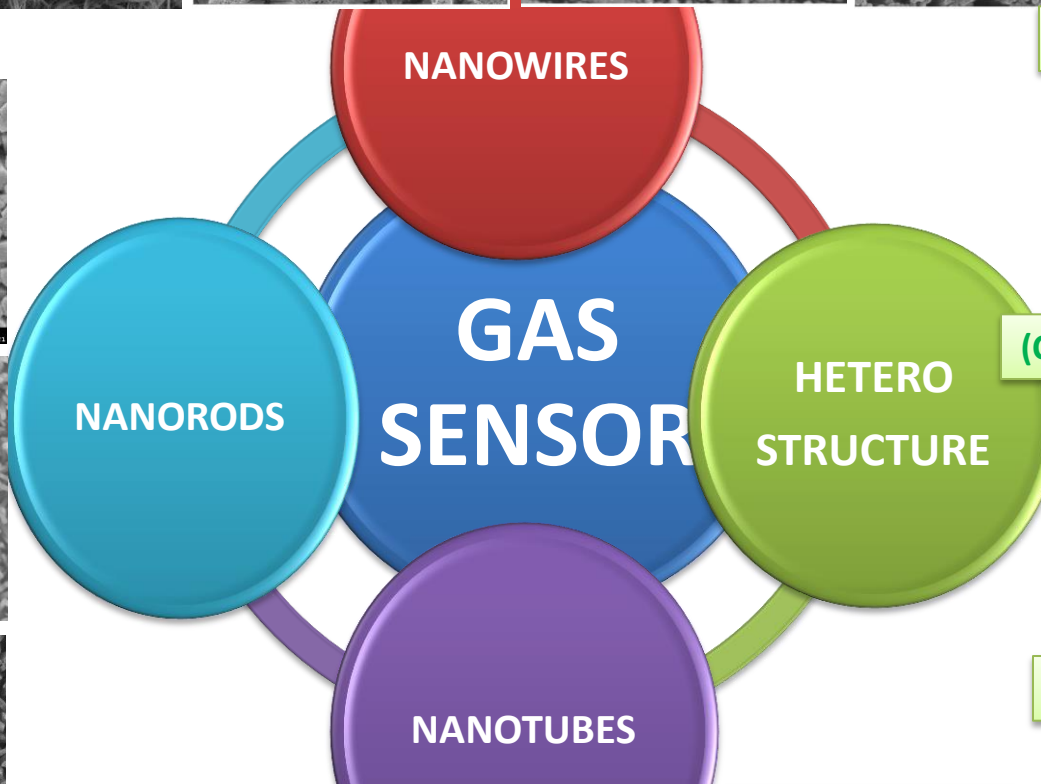
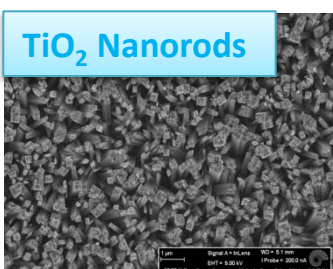
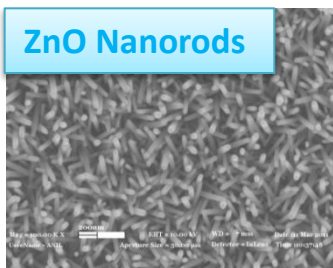
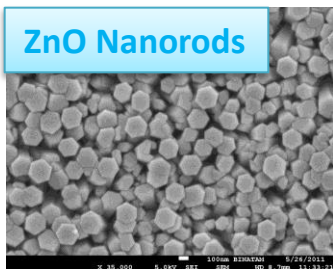
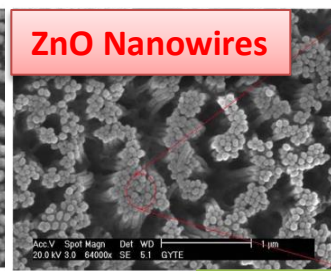
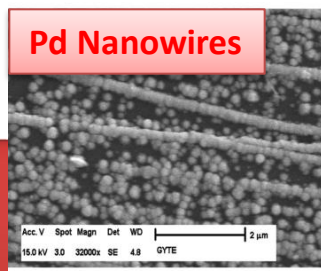
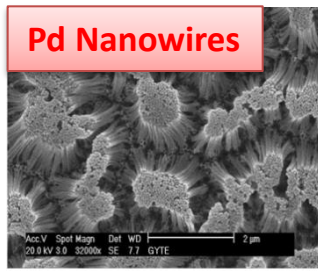
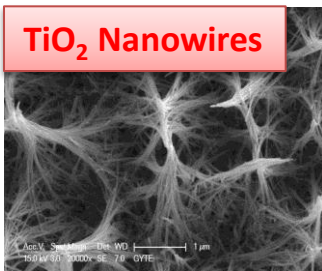
3. Results

- Structural Analysis (SEM, EDX, XPS, XRD)
- Gas Measurements

4. Conclusions

1. Introduction

- **Main Research Area**
- **Motivation of This Work**

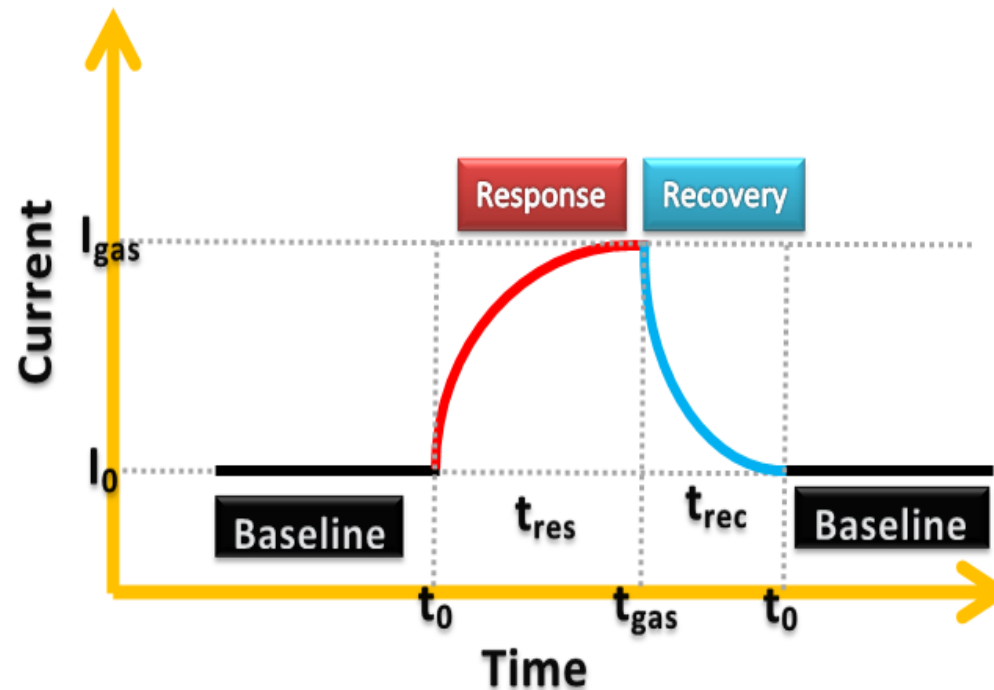


Promoting of sensing properties of metal oxides by decoration.

↓ $T_{\text{operation}} \sim \text{Power Consumption}$

↑ **Sensitivity , Sensor Response**

$$S = I_{\text{gas}}/I_0 \quad , \quad Rs = (I_{\text{gas}} - I_0)/I_0$$



2. Experimental

- **Fabrication of TiO₂ nanorods**
- **Decoration of Pd nanoparticles on TiO₂ nanorods**
- **Sensor Device**

Preparing of FTO substrate

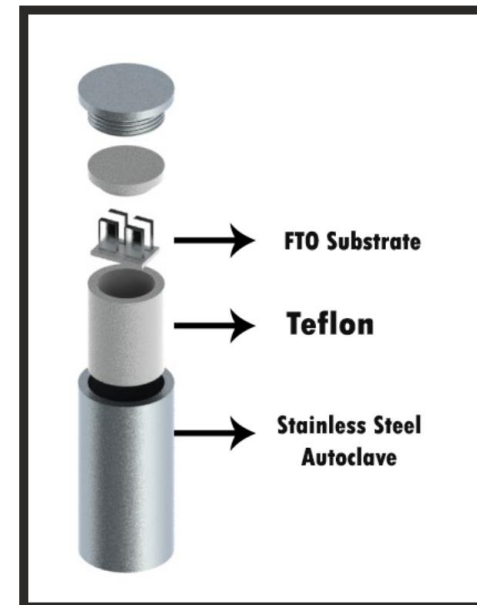
Hydrothermal Method

Cleaning:

Acetone, Etanol for each 10 mins.

Wrapping:

Appropriate sample holder



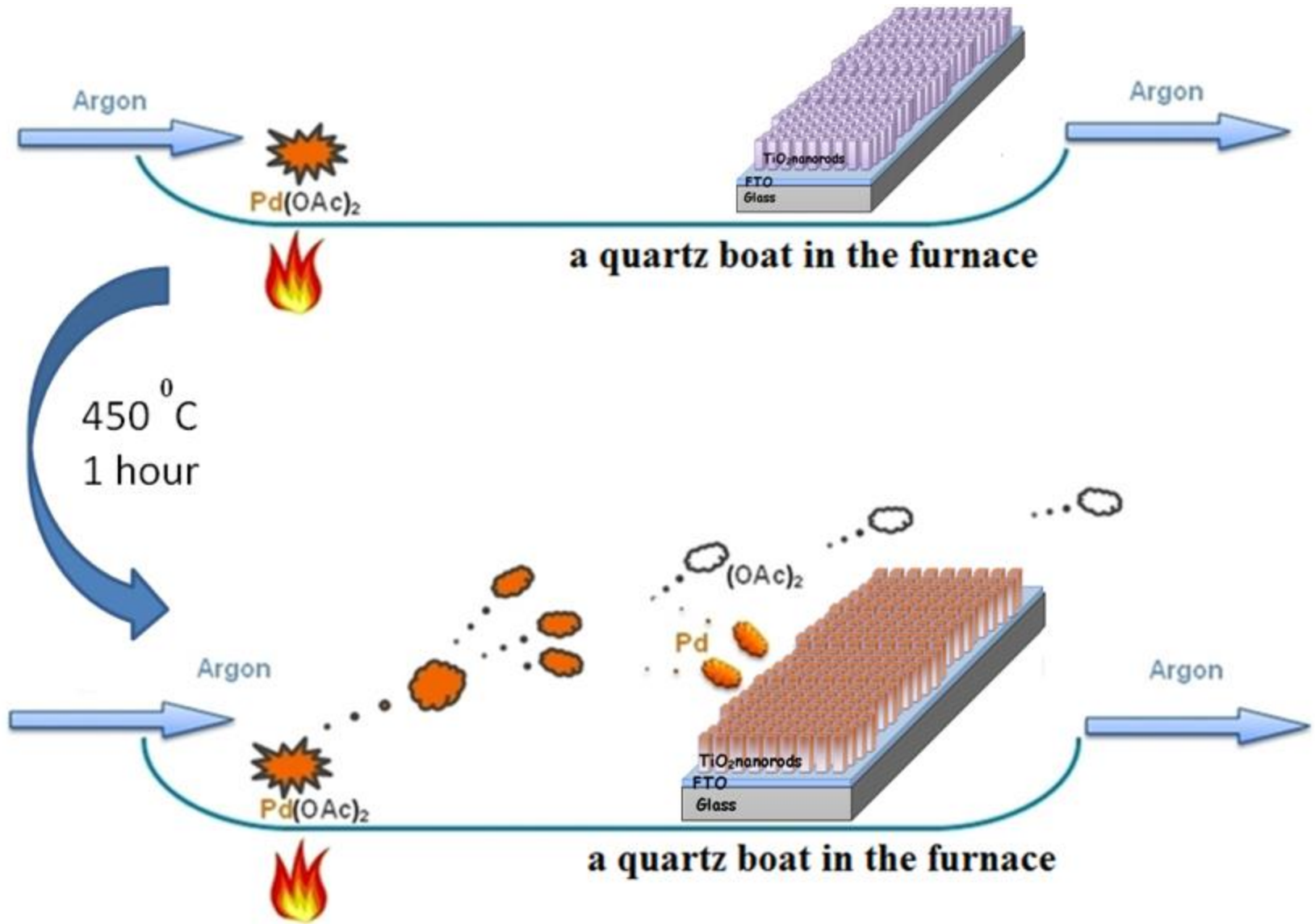
Solution:

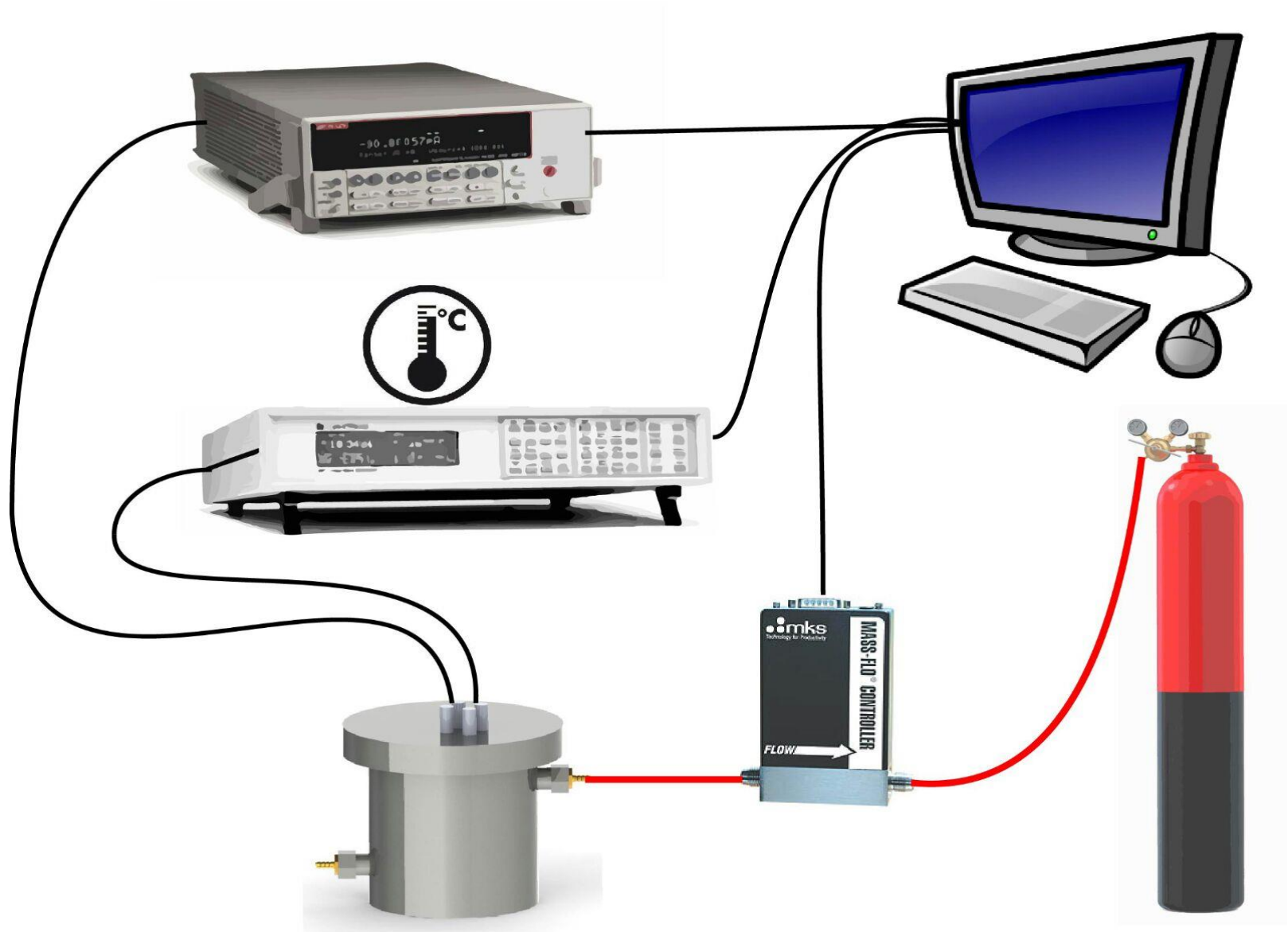
30 ml HCl
30 ml Dei water
1 ml Ti n-BT

Hydrot. process:

150 °C
18 hours

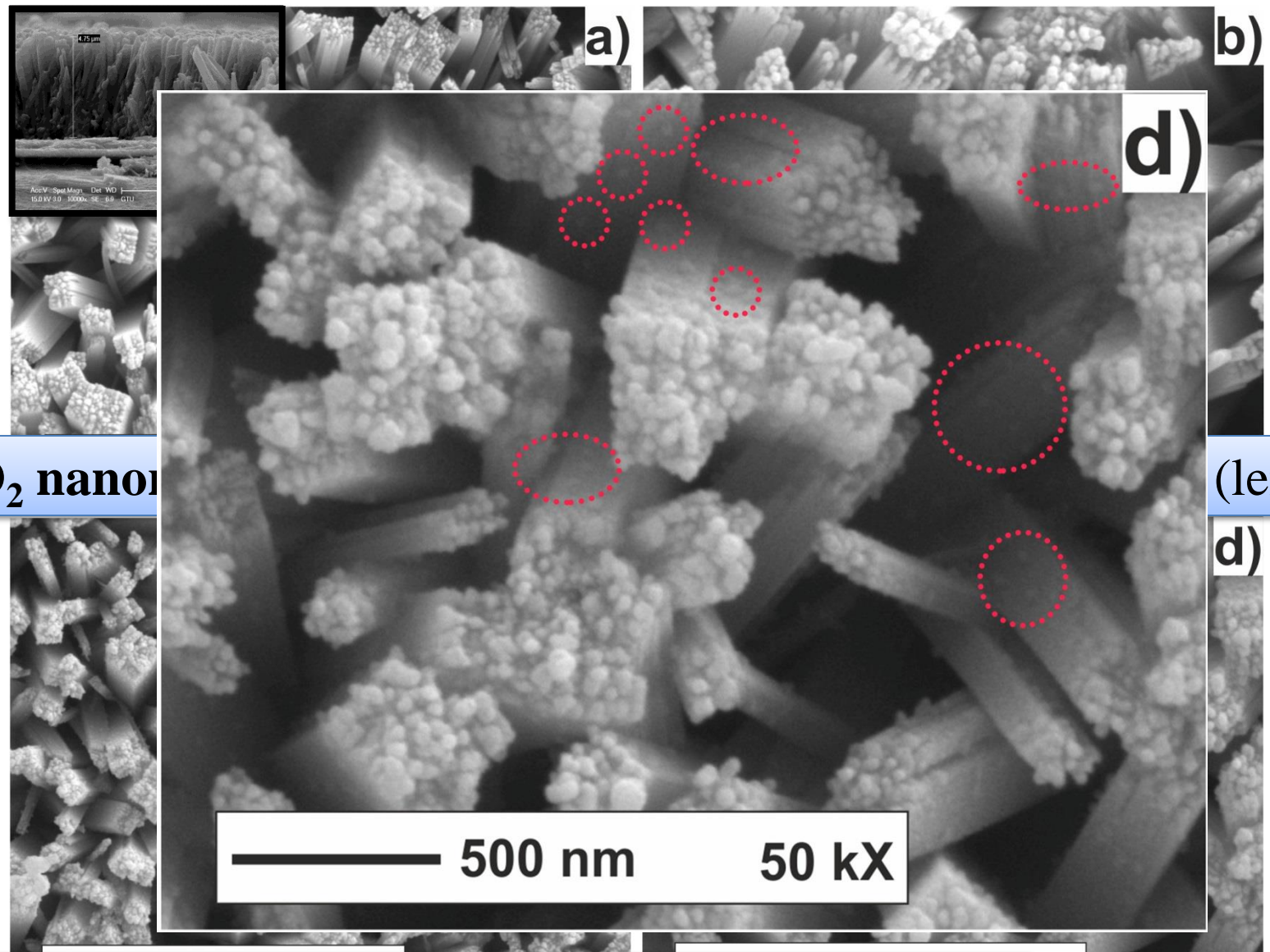
Decoration of Pd nanoparticles on TiO₂ nanorods





3. Results

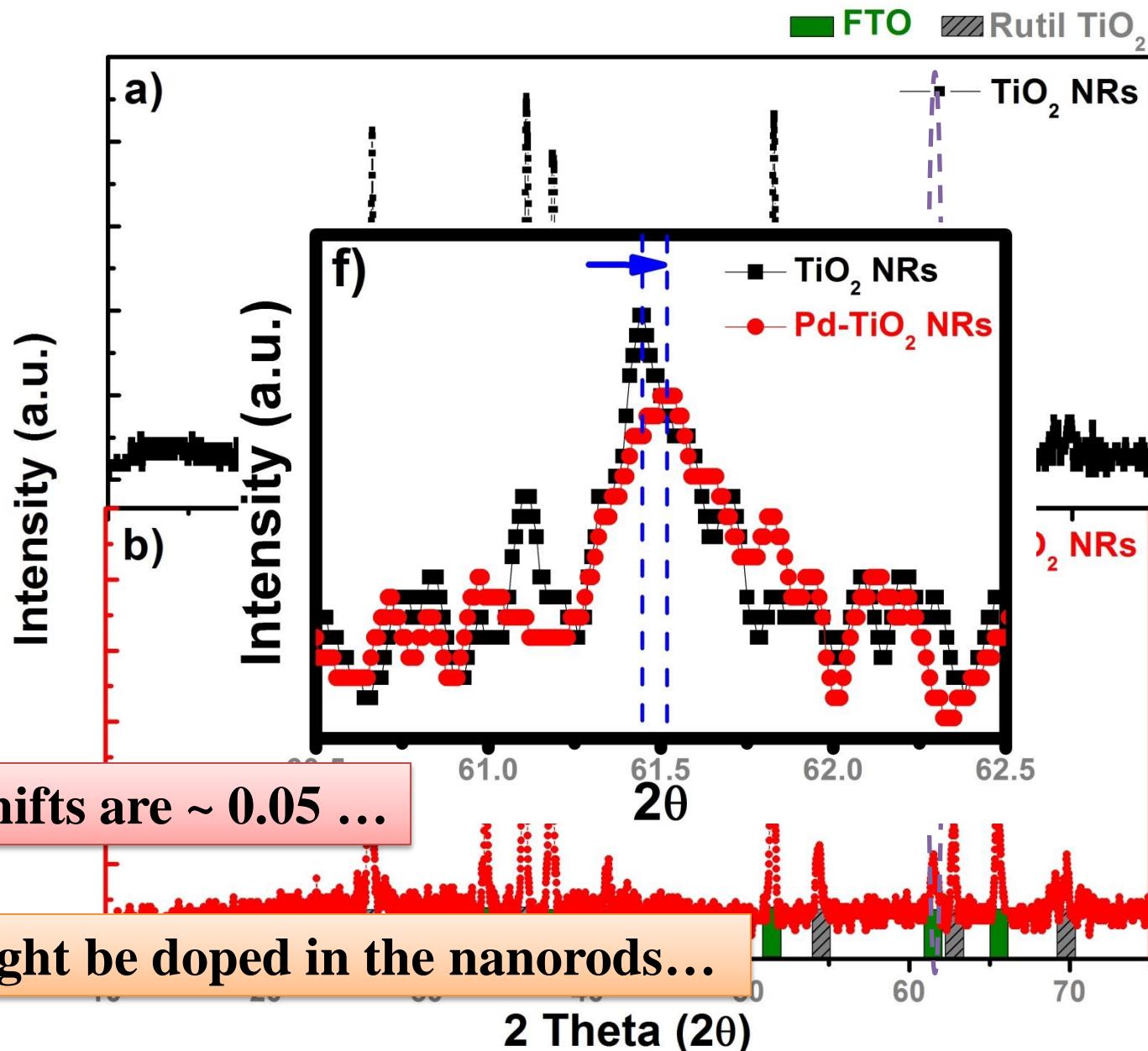
- **Structural Analysis (SEM, XRD, XPS)**
- **Gas Measurements (I-t, Rs %, Rs)**



TiO₂ nanorods

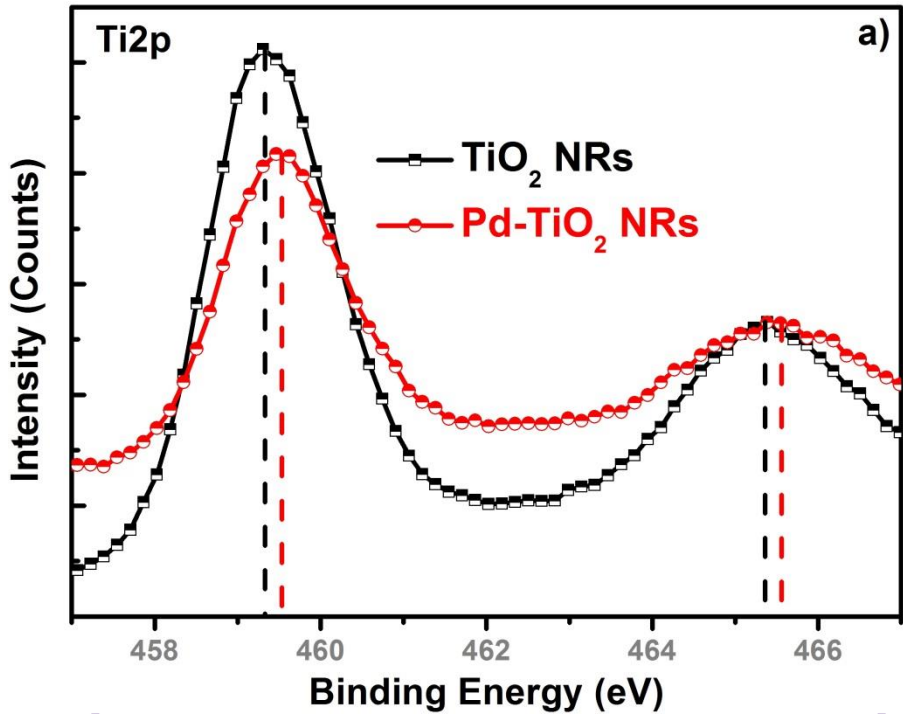
(length)

Pd decoration: spherical shape, ~10 nm (diameter) kX



The shifts are ~ 0.05 ...

Pd might be doped in the nanorods...

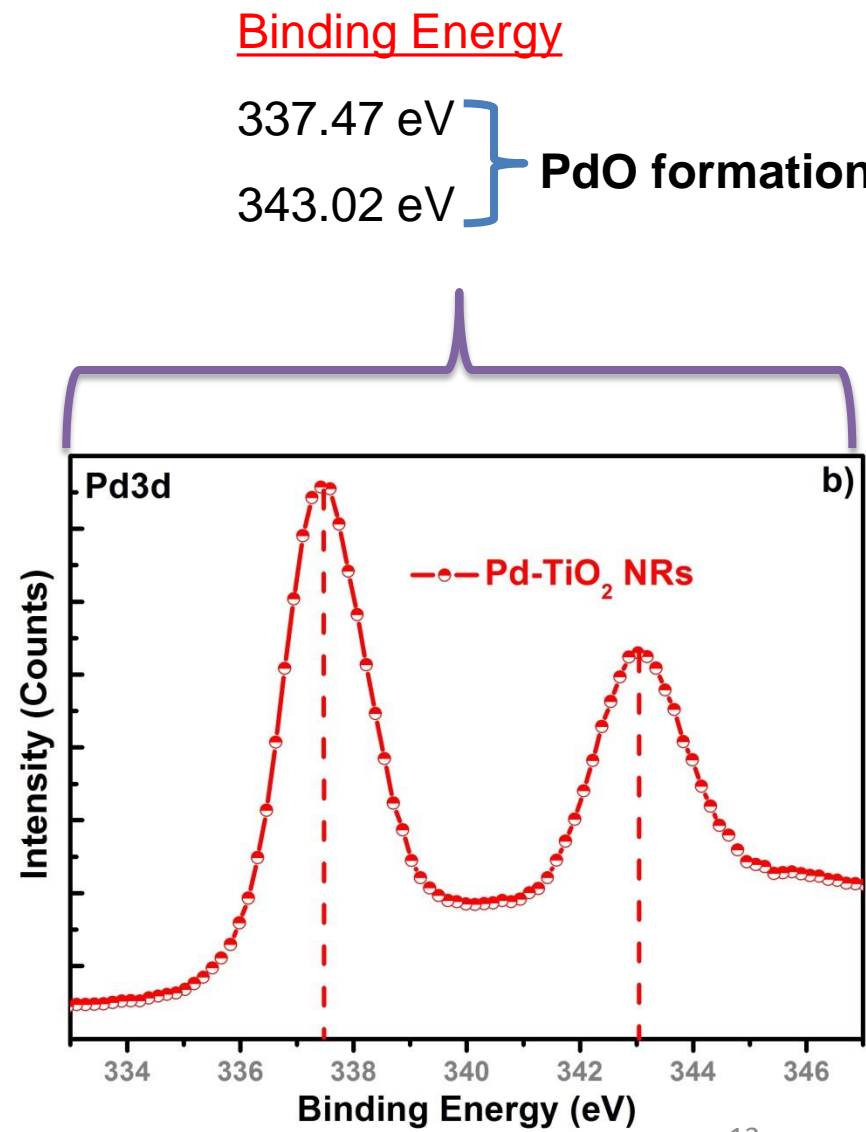


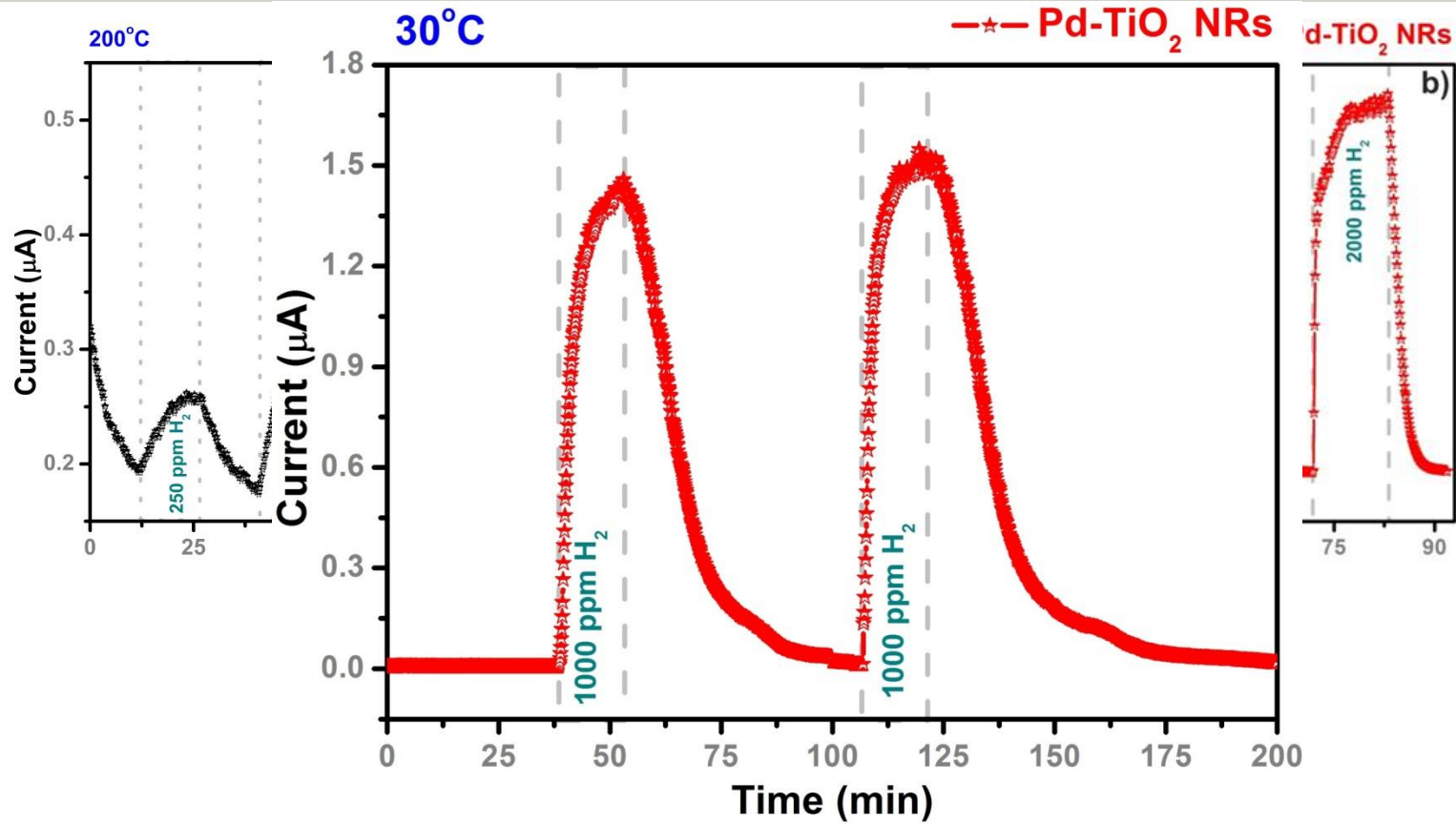
Binding Energy

459.32 eV } TiO_2 formation

465.35 eV }

The shifts are ~ 0.2 eV





1000 ppm H₂ at 200 °C

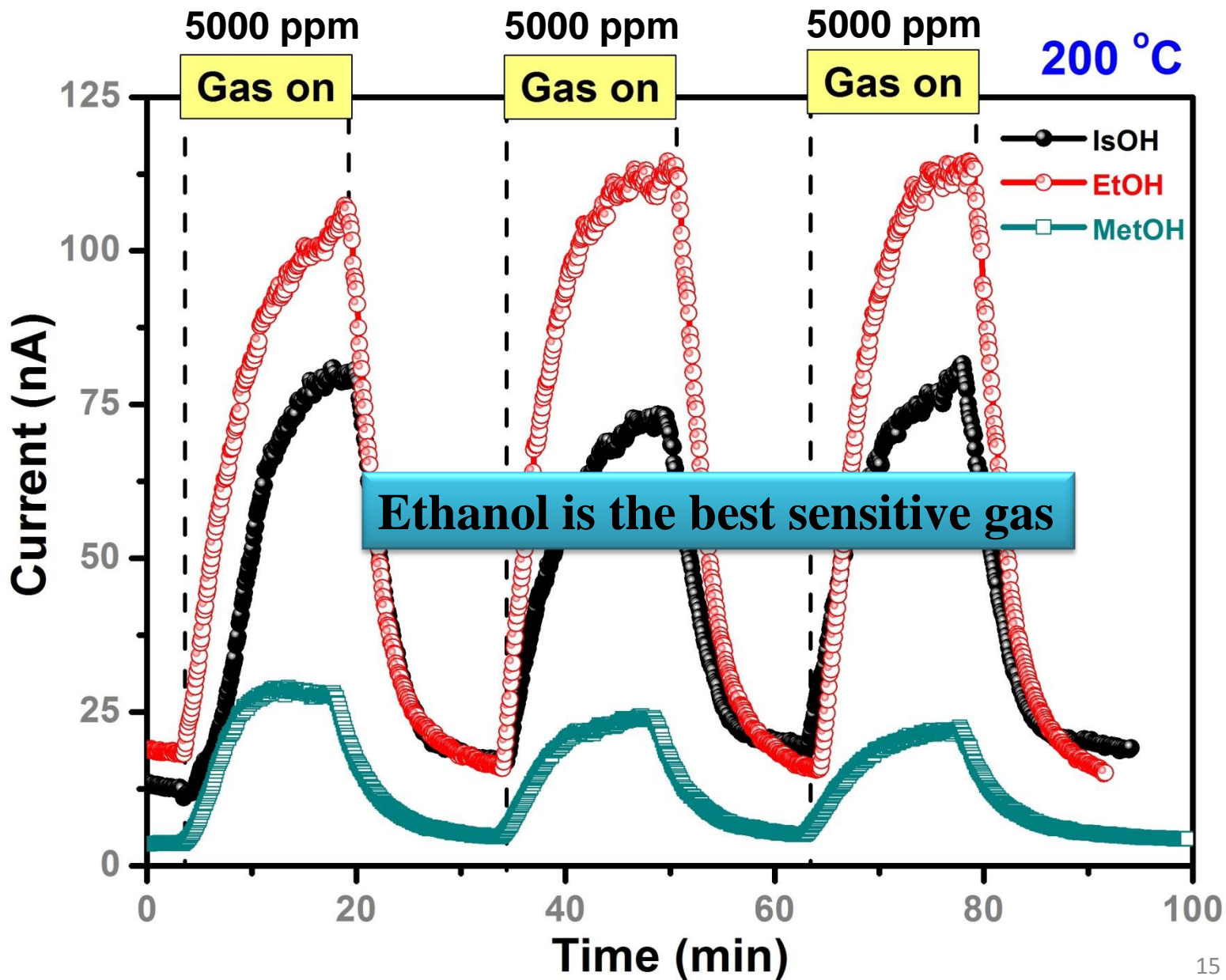
$t_{\text{response}} = 15$ min for TiO₂ nanorods

$t_{\text{response}} = 3$ min for Pd-TiO₂ nanorods

1000 ppm H₂ at 30 °C

$t_{\text{response}} = \text{no response}$

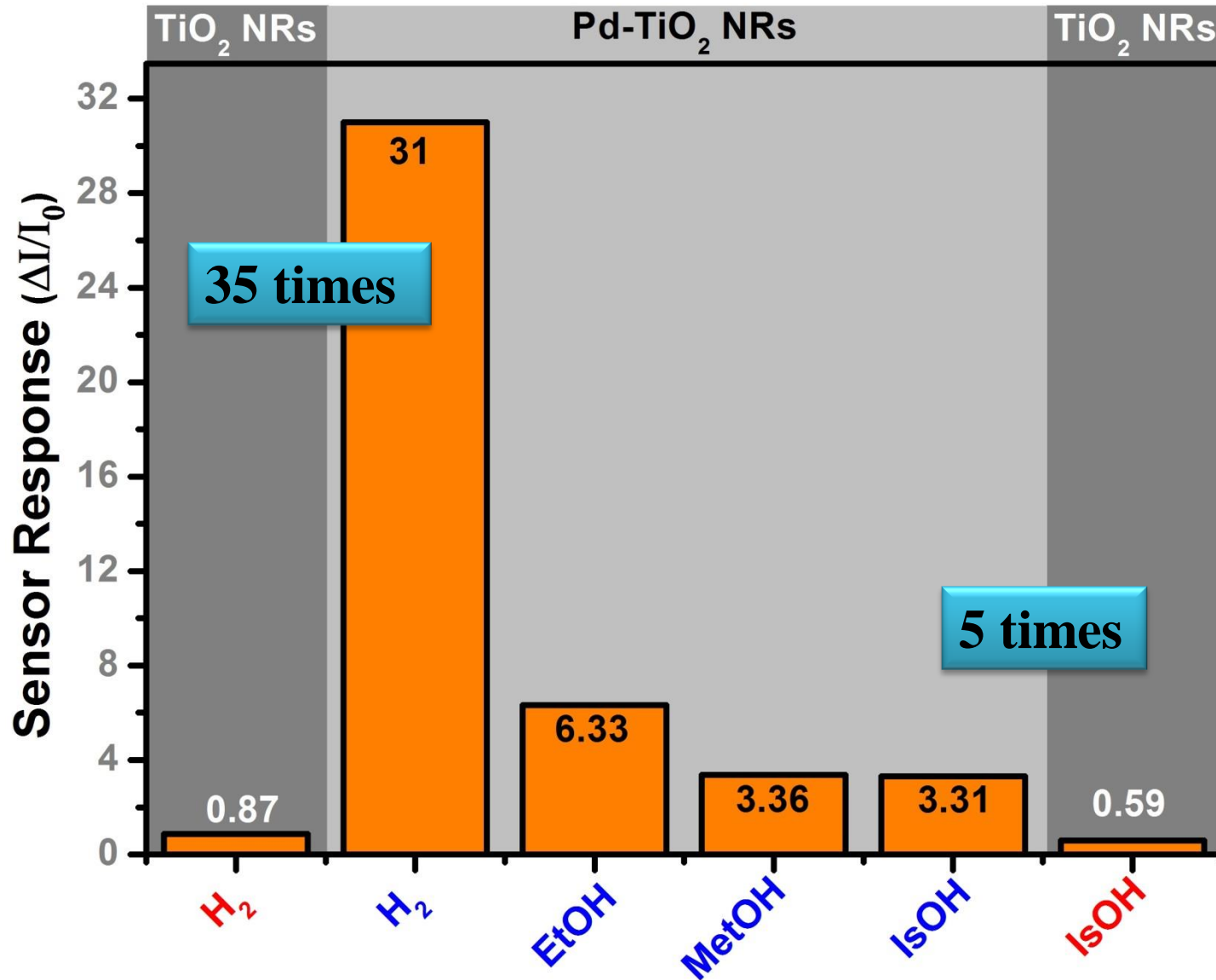
$t_{\text{response}} = 15$ min for Pd-TiO₂ nanorods



Sensor Response: $R_s = (\Delta I_{\text{gas}} - I_0) / I_0$

5000 ppm VOC

1000 ppm H₂



4. Conclusions

- TiO_2 nanorods (on FTO) \rightarrow Hydrothermal method
Pd nanoparticles on TiO_2 nanorods \rightarrow Chemical Vapor Deposition (CVD)
- We have investigated to hydrogen gas sensing features of Pd loaded TiO_2 nanorods in different concentrations (100-800 ppm) at 200 °C.
- Pd- TiO_2 NR device shows a great increment for 1000 ppm H_2 with almost 250 of sensor response.
- Our purpose in this work:

↓ $T_{\text{operation}} \sim$ Power Consumption

↑ Sensitivity , Sensor Response

$$S = I_{\text{gas}}/I_0 \quad , \quad Rs = (I_{\text{gas}} - I_0)/I_0$$





??? THANK YOU ???

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