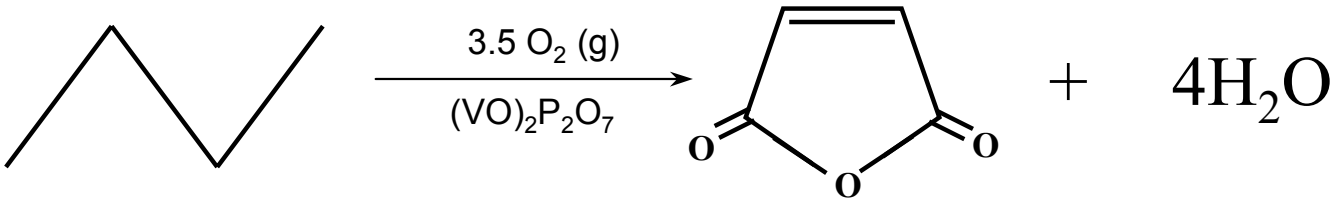
VPO catalysts for the oxidation of n-butane to MA

ANDRZEJ LISKOWSKI

Introduction

Oxidation of n-butane to maleic anhydrate



APPLICATIONS

unsaturated polyester resins

- Fiberglass composites
- Lube oil
- Fumaric acid
- Assorted polymers

Microstructure characterization

microstructure

Set of samples

- single crystal of VPO
- standard phases, e.g. α_I-$VOPO_4$
- CAT series
- VPA, VPD, VPO series

XRD analysis

- phase analysis

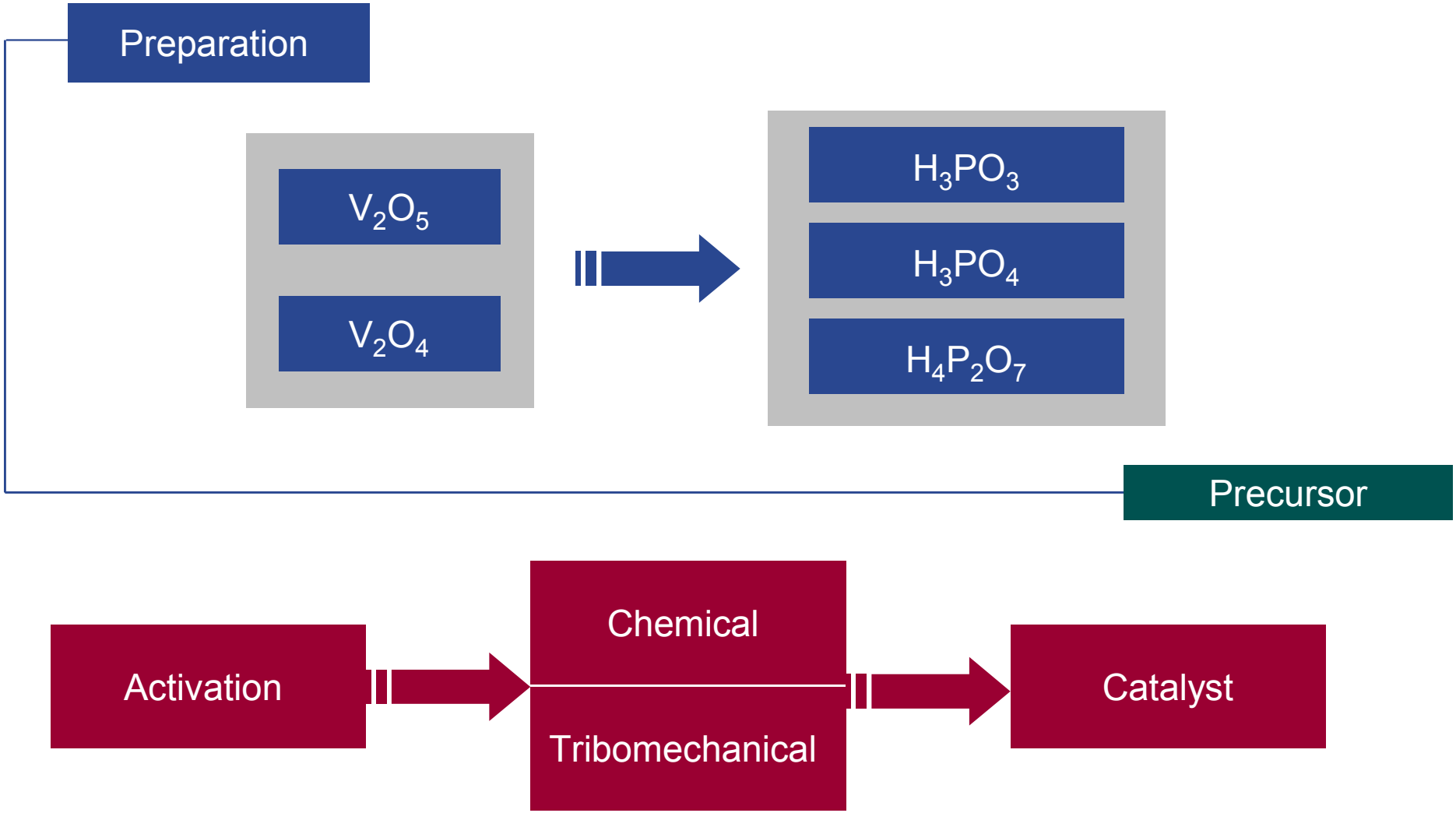
SEM characterization

- morphology
- chemical composition

TEM

- LM images
- HREM images
- diffraction patterns
- EELS

VPO samples


Preparation
V_2O_5
V_2O_4
H_3PO_3
H_3PO_4
$H_4P_2O_7$
Precursor
Activation
Chemical
Tribomechanical
Catalyst

After Activation

Chemical activation

$(VO)_2P_2O_7$

α_I-$VOPO_4$

α_{II}-$VOPO_4$

β-$VOPO_4$?

δ-$VOPO_4$ unknown

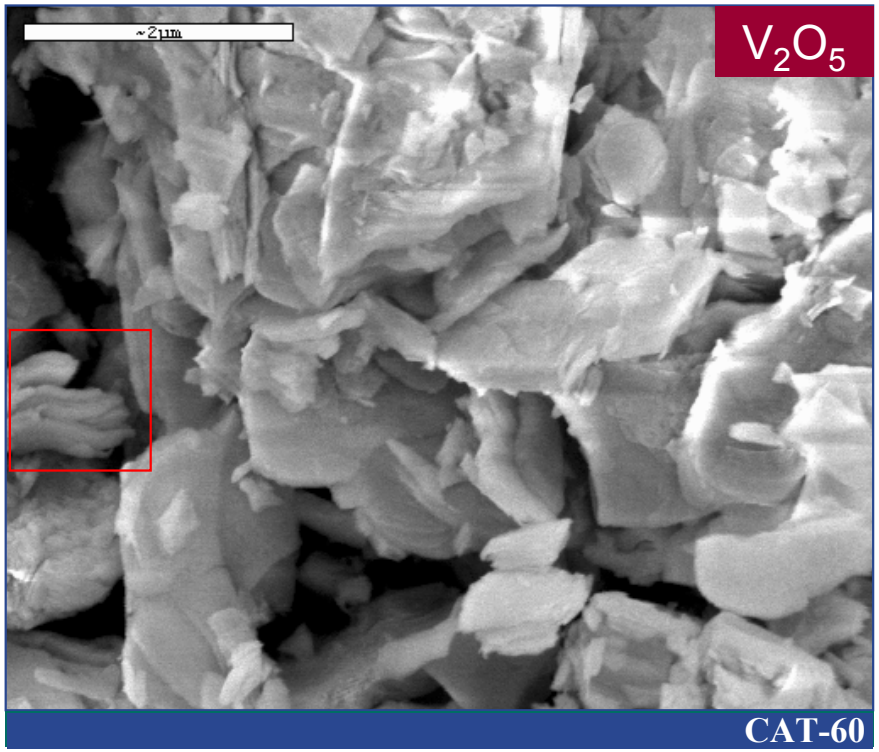
γ-$VOPO_4$ unknown

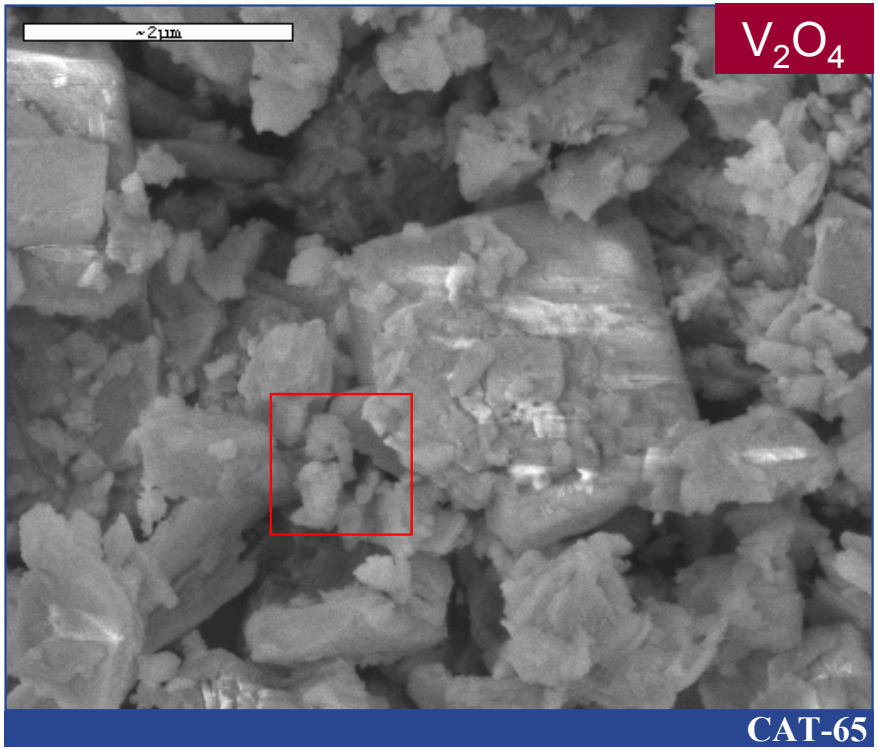
Tribomechanical activation

$(VO)_2P_2O_7$

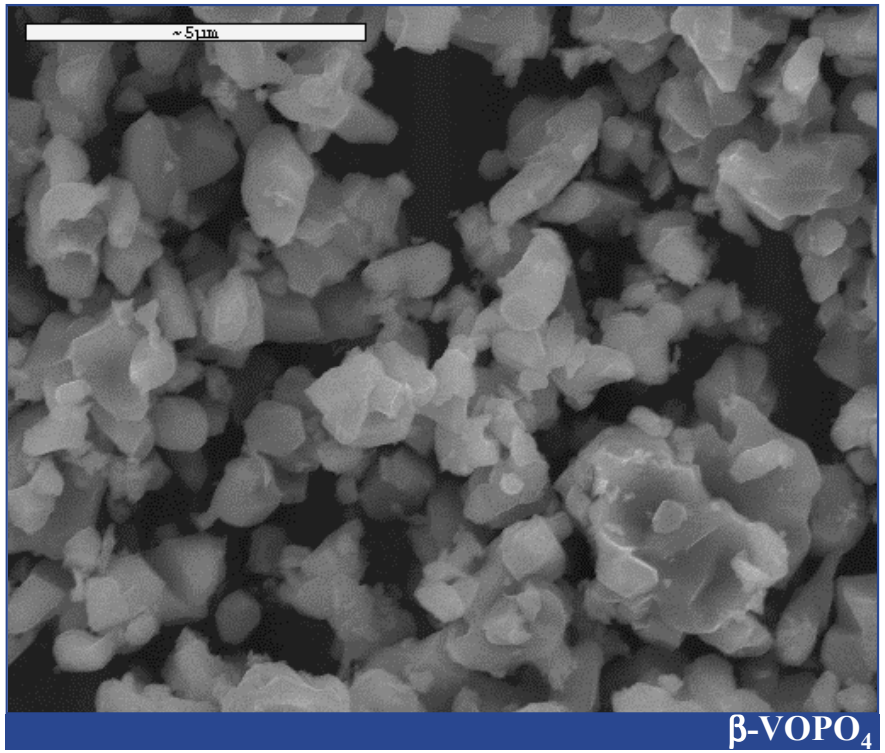
Multiplicity of phases

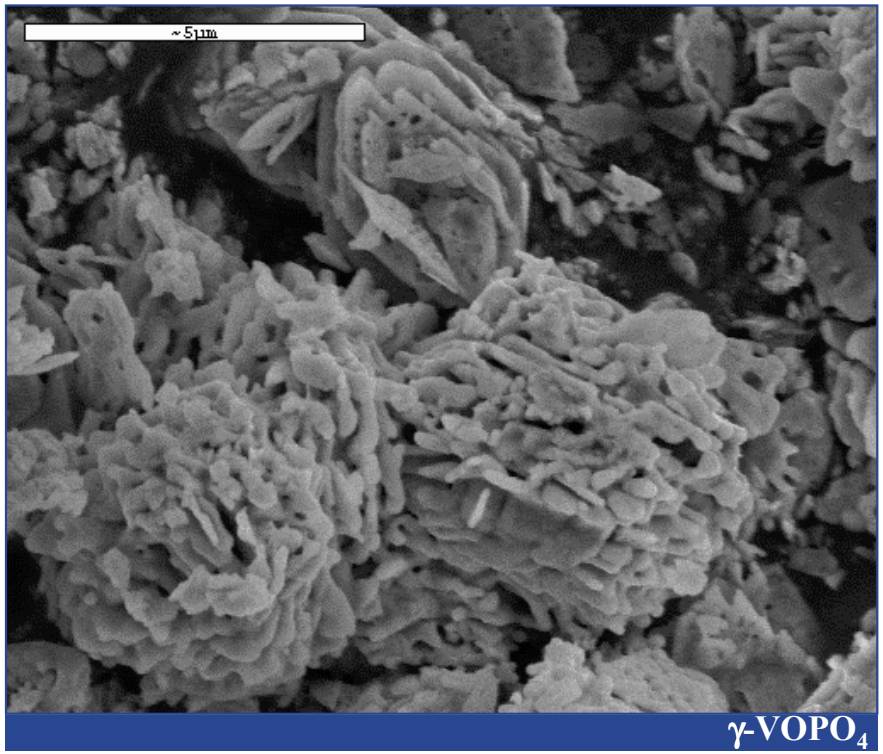
Morphology – SEM images



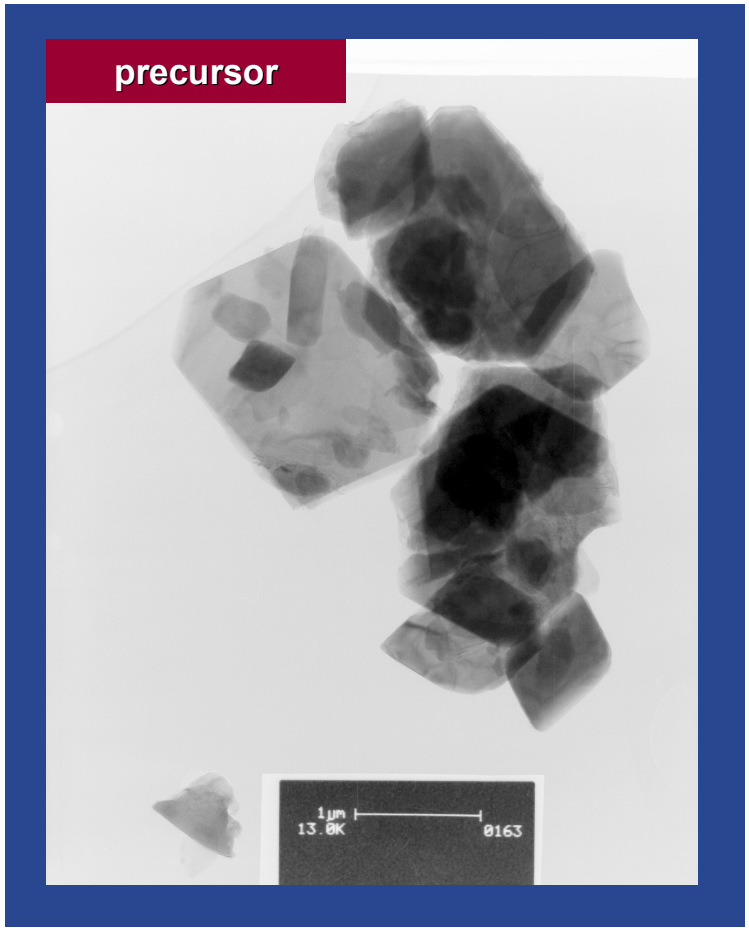


Standard phases: β-, γ-$VOPO_4$

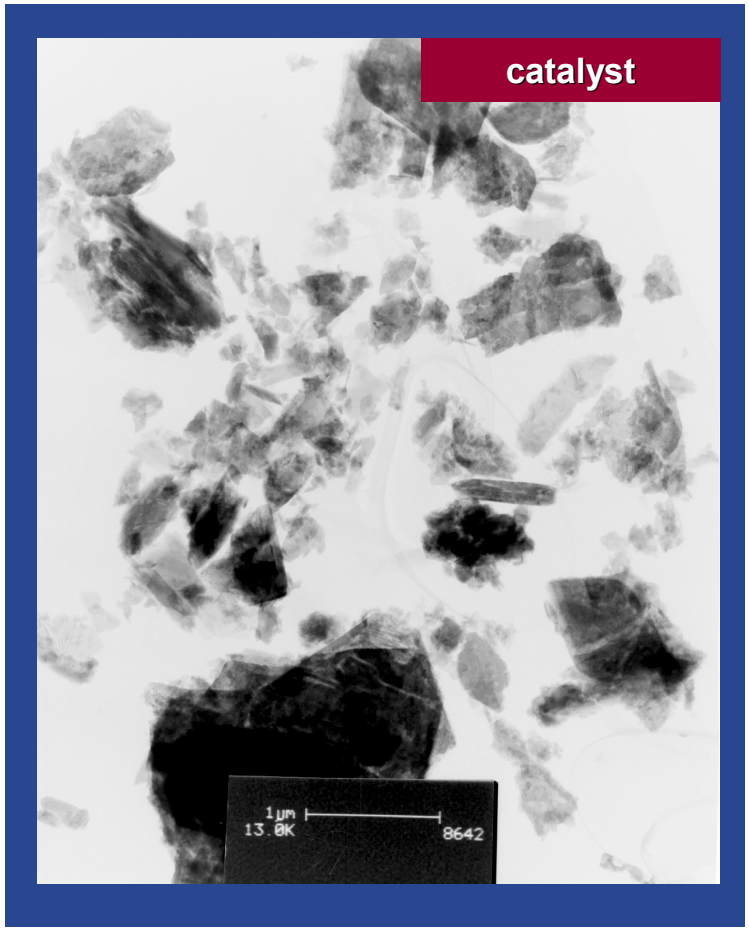




Structure evaluation - DP



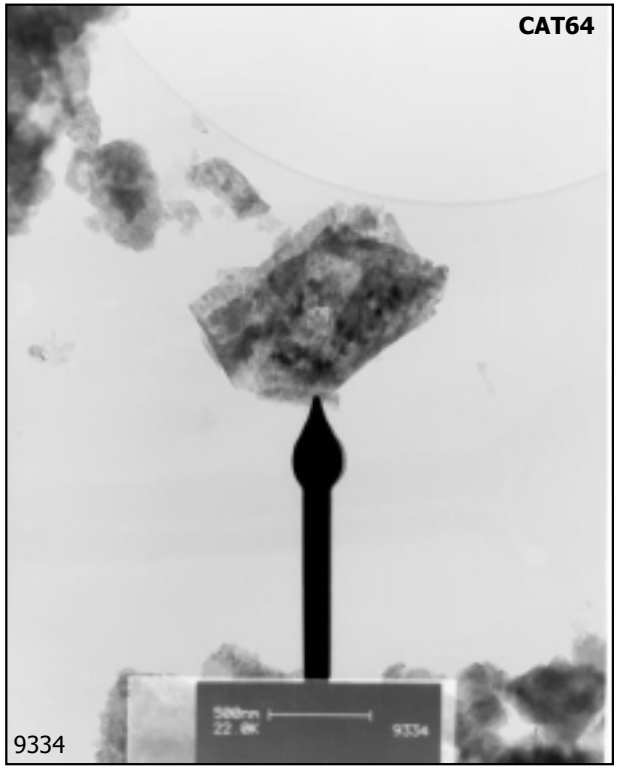
activation

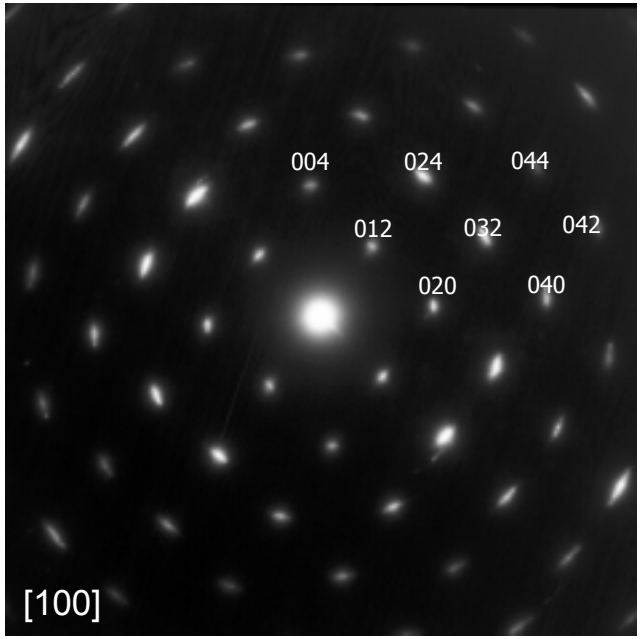


$VOHPO_4 \cdot 0{,}5H_2O$

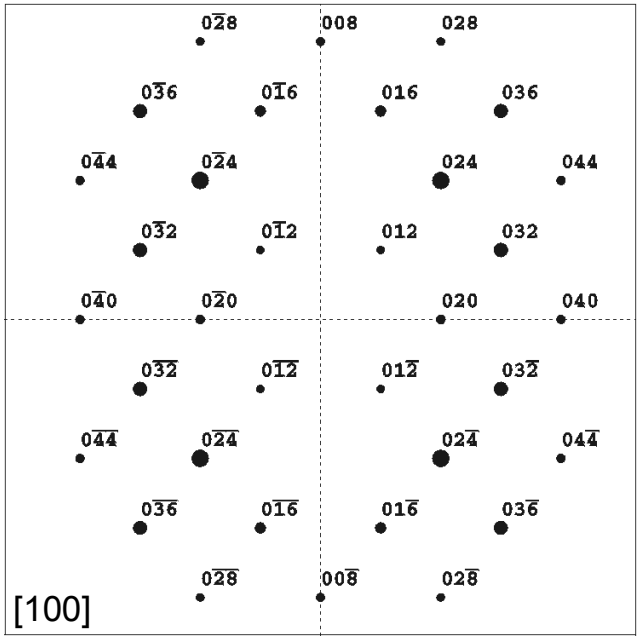
$(VO)_2P_2O_7$, V^{5+} phases

Closer look - DP



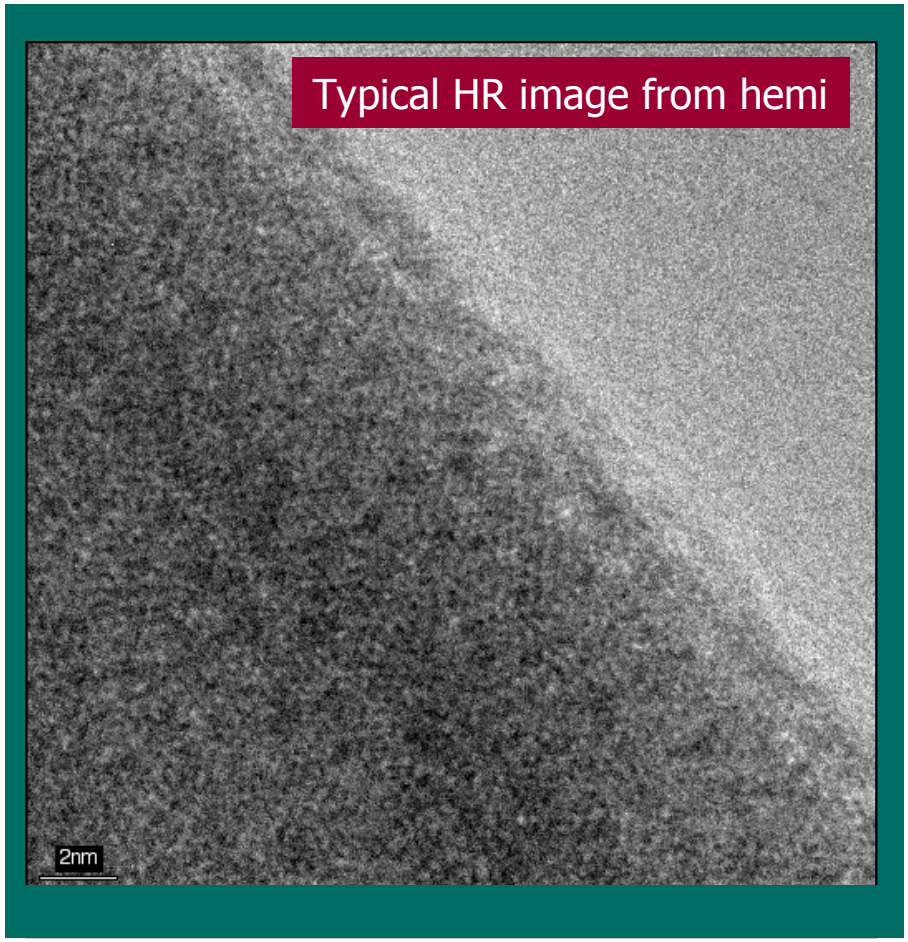


Experimental DP

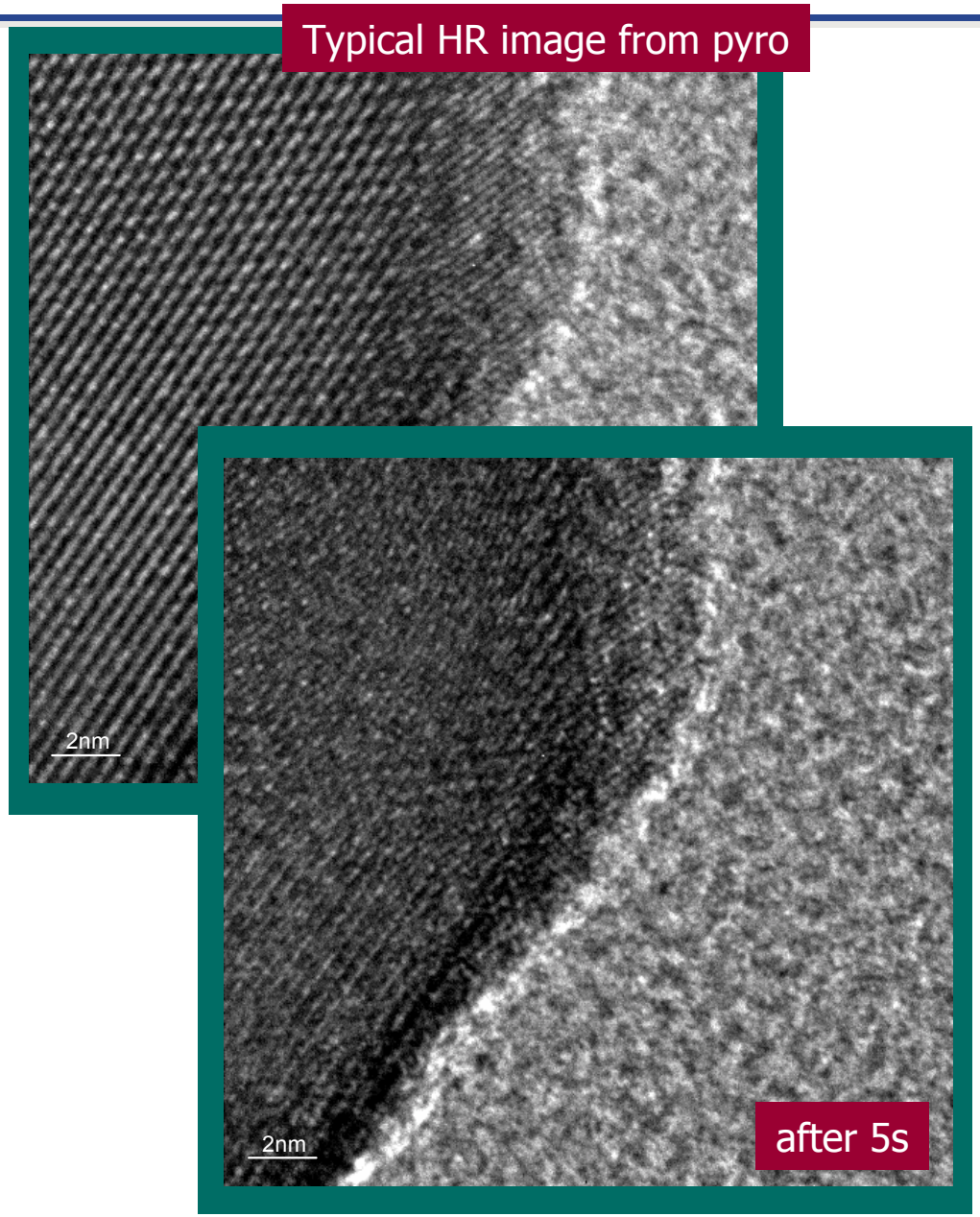


Simulated DP

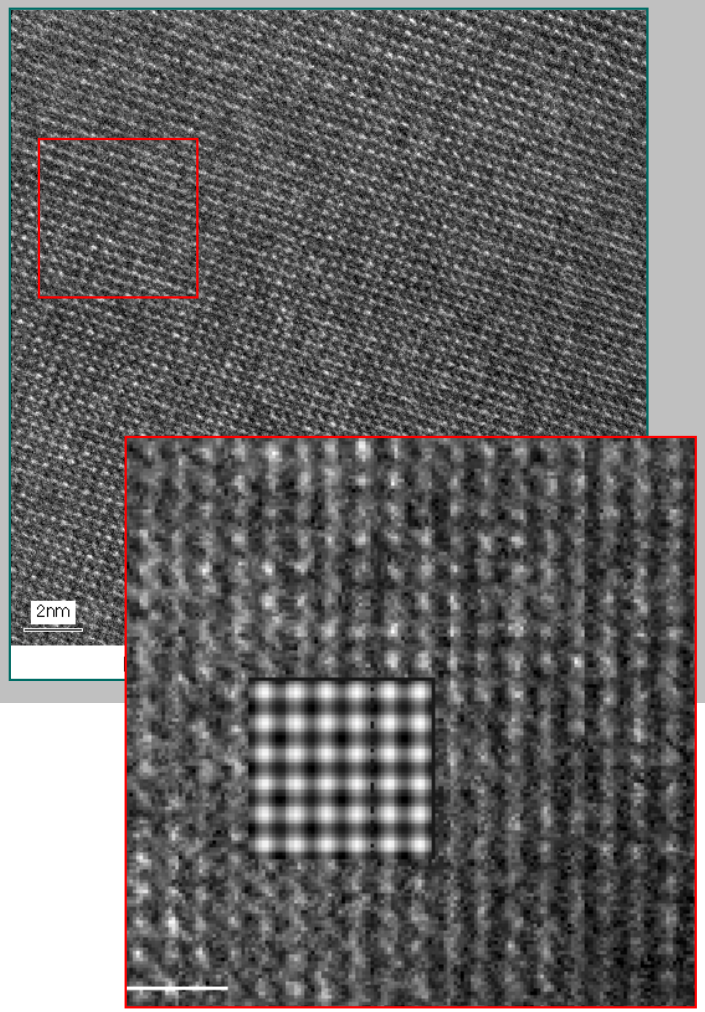
HR images: hemihydrate and pyrophosphate

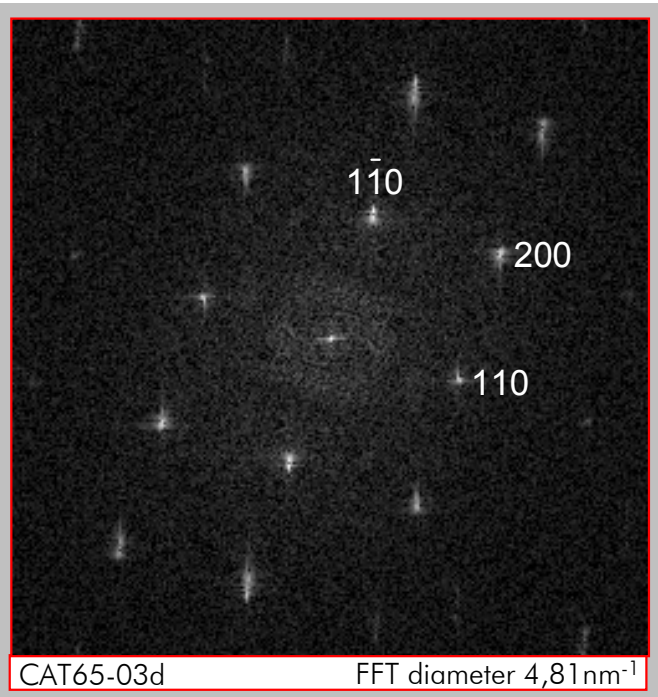


$VOHPO_4 \cdot 0,5H_2O$



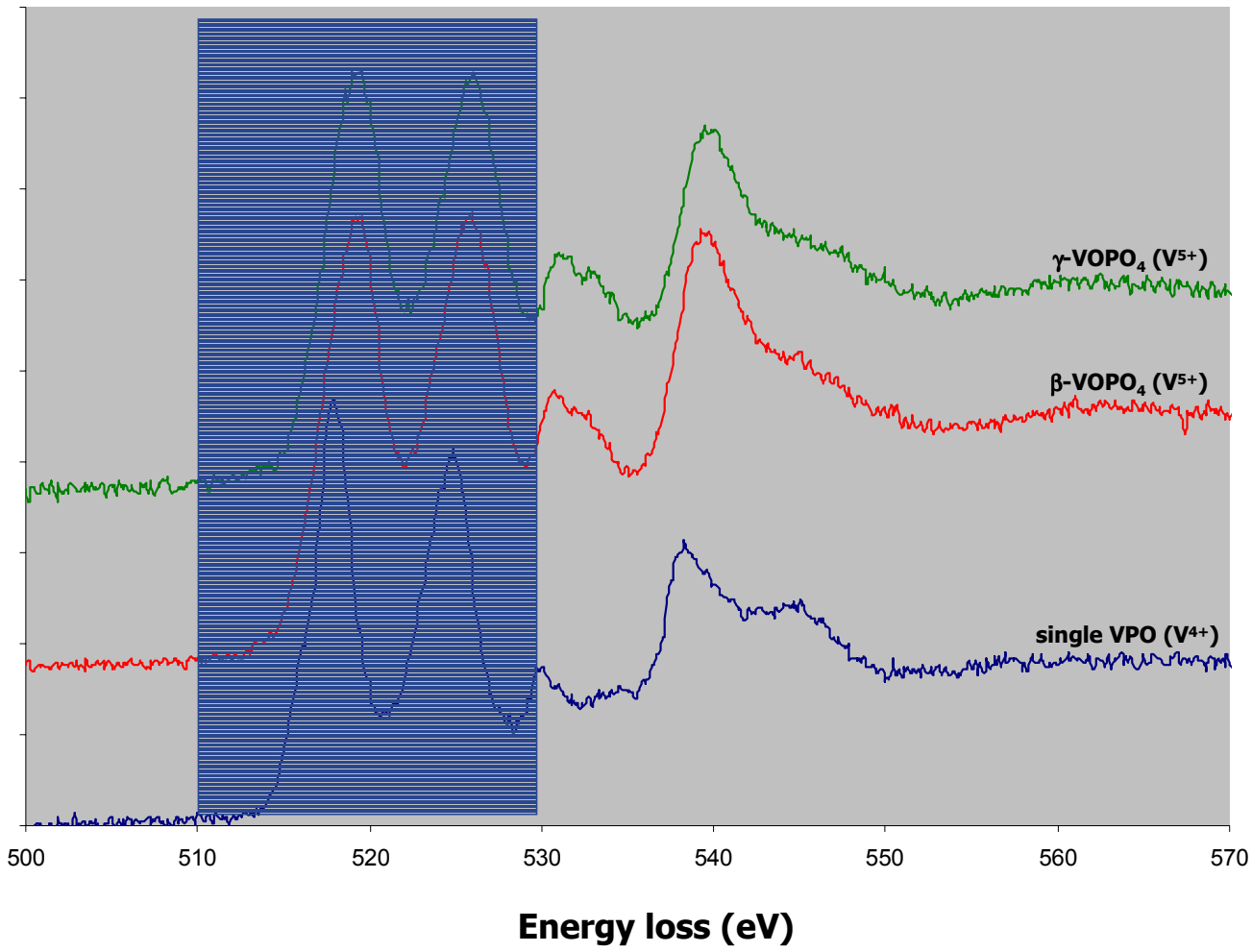
Microstructure - α_I-$VOPO_4$





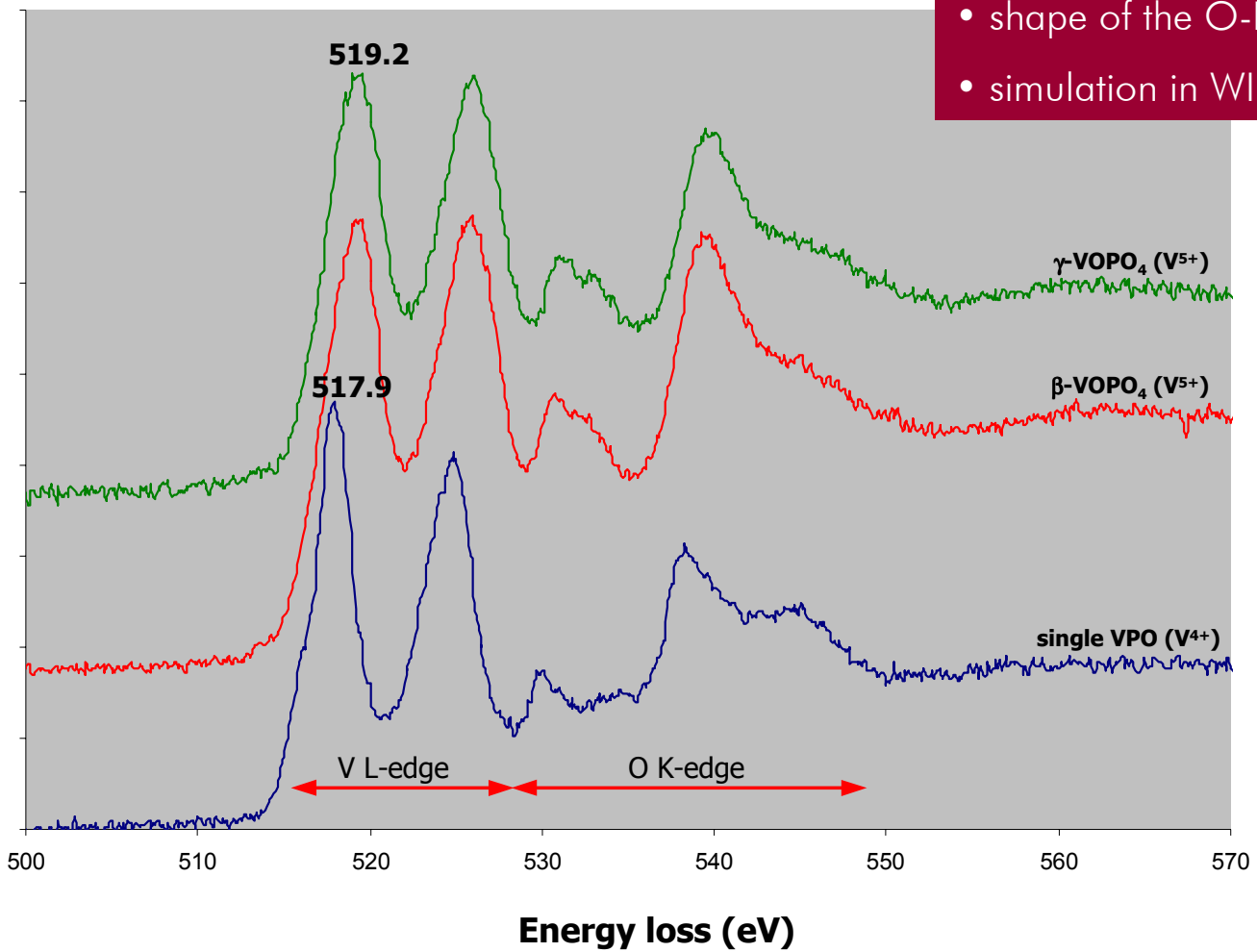
Experimental image «-------» Image Simulation

Electron Energy Loss Spectrum

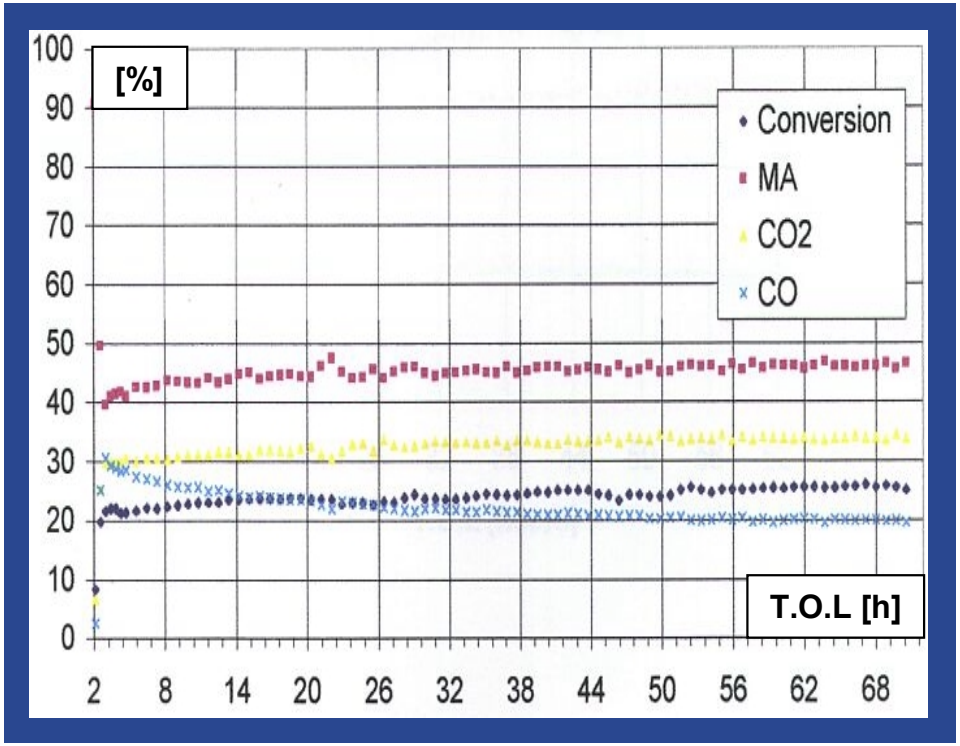


Electron Energy Loss Spectrum

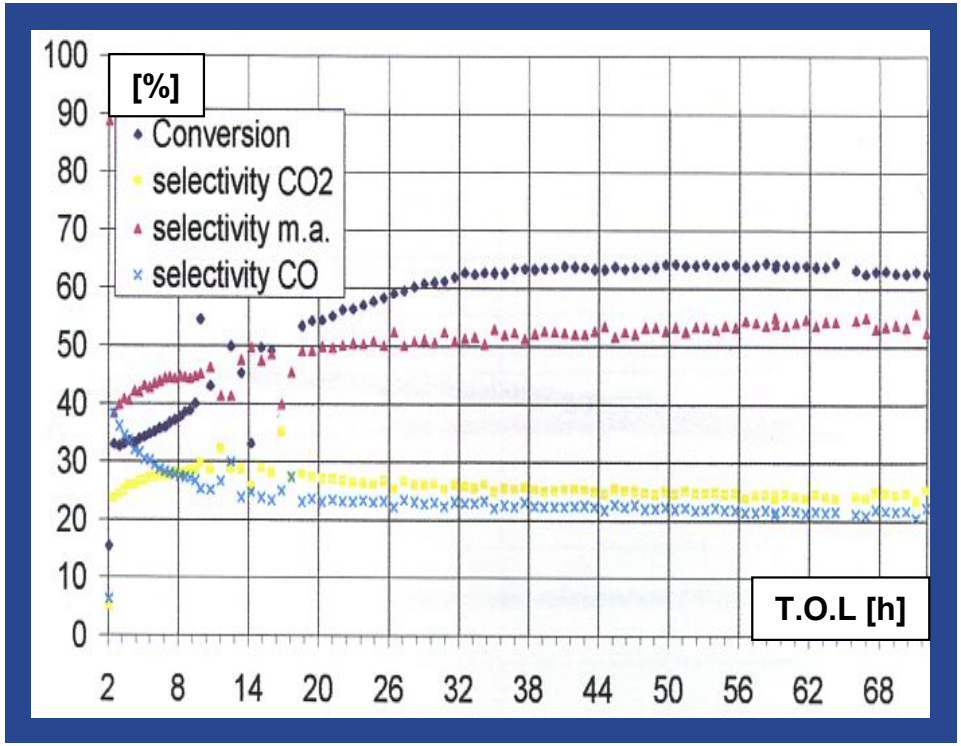
- position of V-L_3 edge
- shape of the O-K edge
- simulation in WIEN2K



Catalytic performance



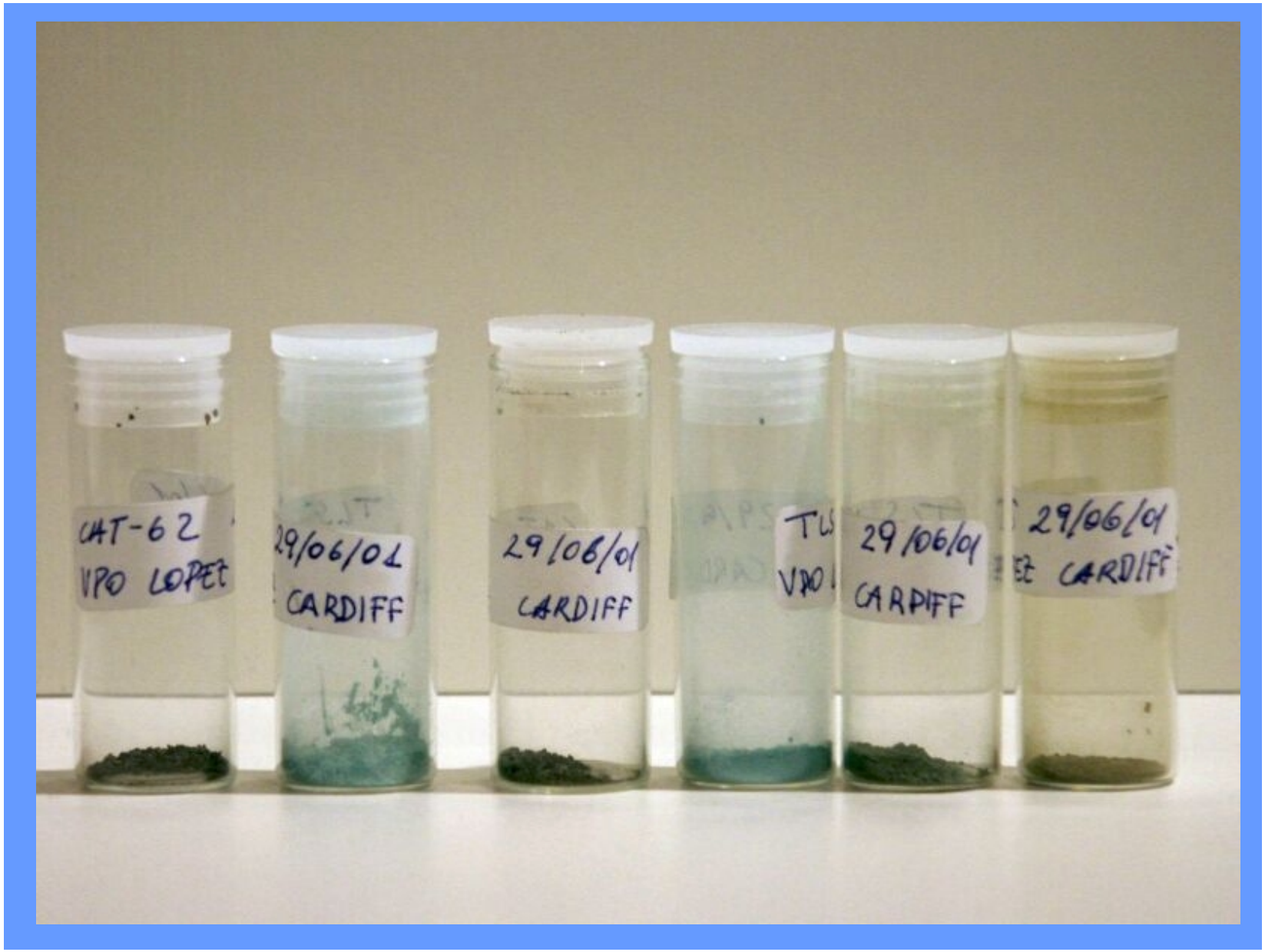
cat60



cat61

Microstructural changes after refluxing?

Thank you!


CAT-62
VPO LOPEZ
29/06/01
CARDIFF
29/06/01
CARDIFF
29/06/01
CARDIFF
29/06/01
CARDIFF