CSAC 2021
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SnO_2 sensing performance toward volatile flavour compounds

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OUTLINE

Introduction

- MOS sensor
- Diacetyl

Materials and Methods

- SnO_2 preparation
- XRD and SEM characterization
- Working conditions

Results

- Different carriers
- Diacetyl and Diacetyl-Ethanol solutions
- Diacetyl concentrations

Conclusions

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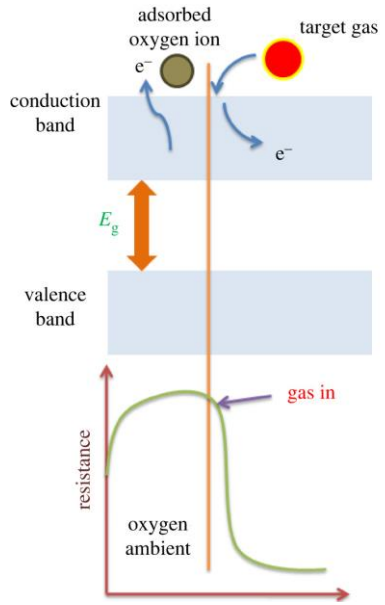
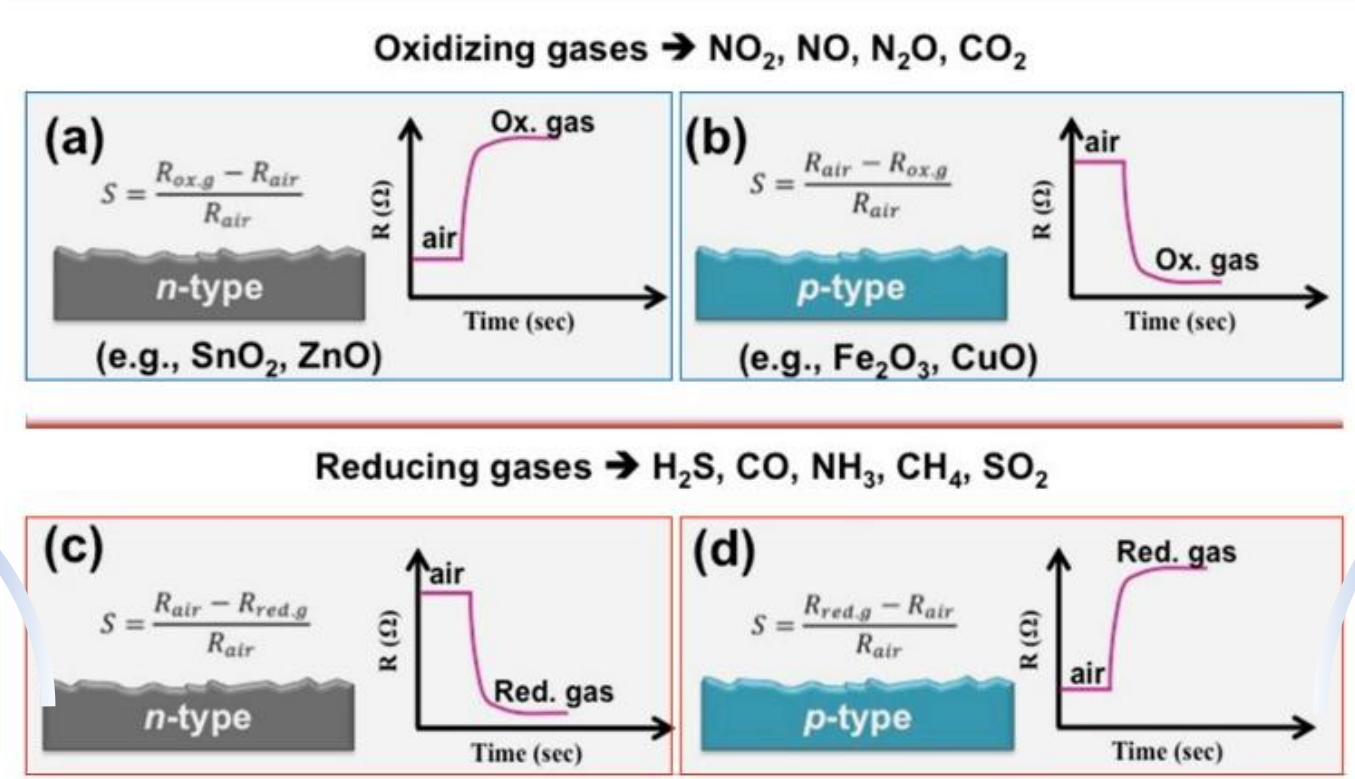
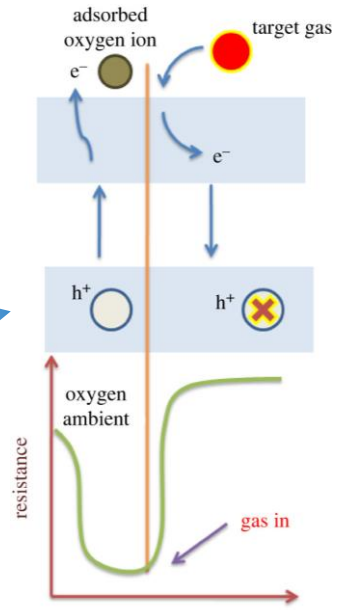
MOS Sensors

Metal oxide semiconductor gas sensors advantages:

- ✓ Easy to use
- ✓ Low cost
- ✓ High sensitivity
- ✓ Fast response time
- ✓ Fast recovery time
- ✓ Detect several gases







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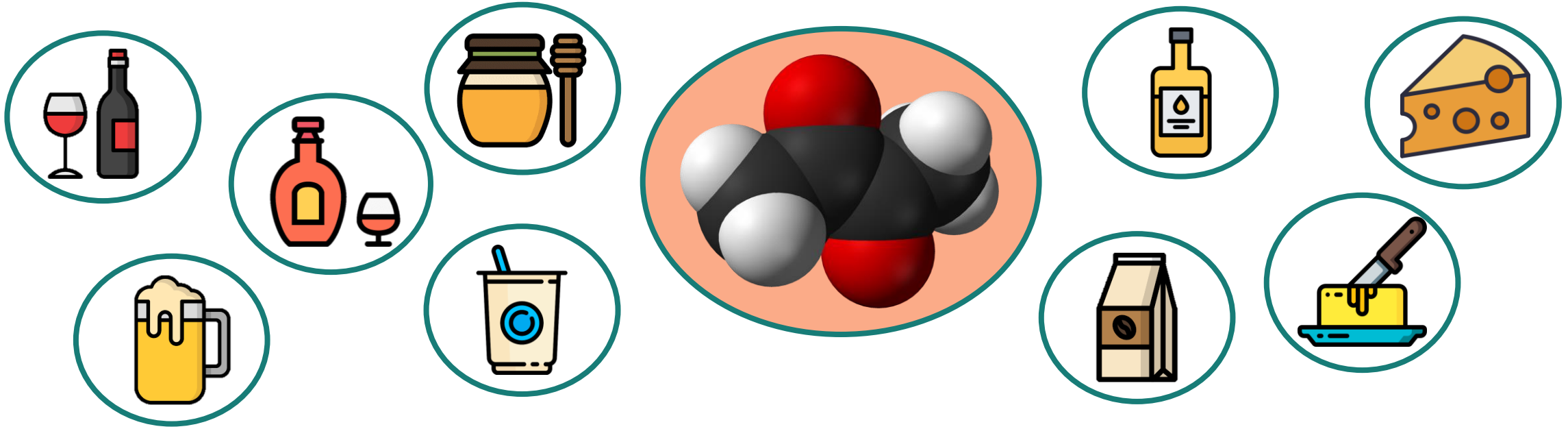
Why Diacetyl?

- Diacetyl ($C_4H_6O_2$) is a vicinal diketone (two C=O groups, side-by-side)
- Diacetyl is naturally produced during the fermentation and the food storage processes
- Diacetyl confers a butter-like aroma in many foods and beverages



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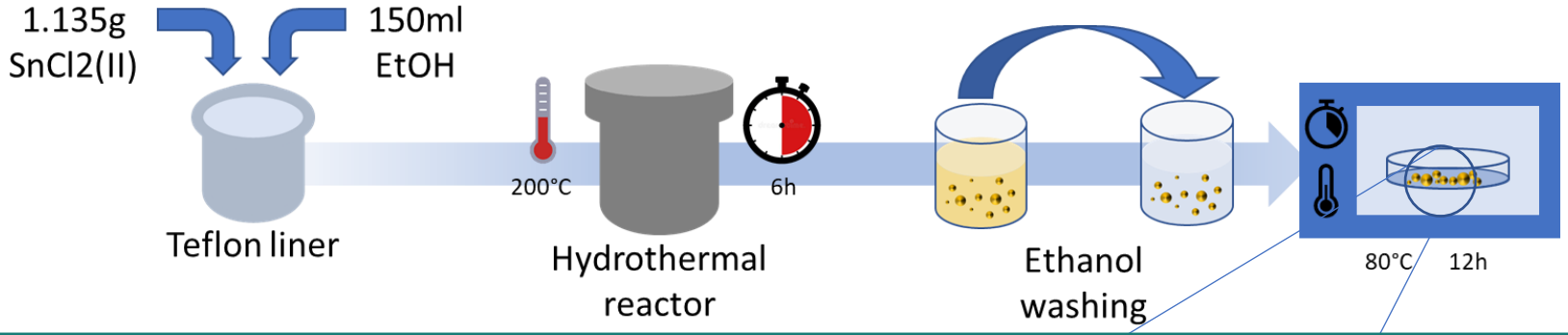
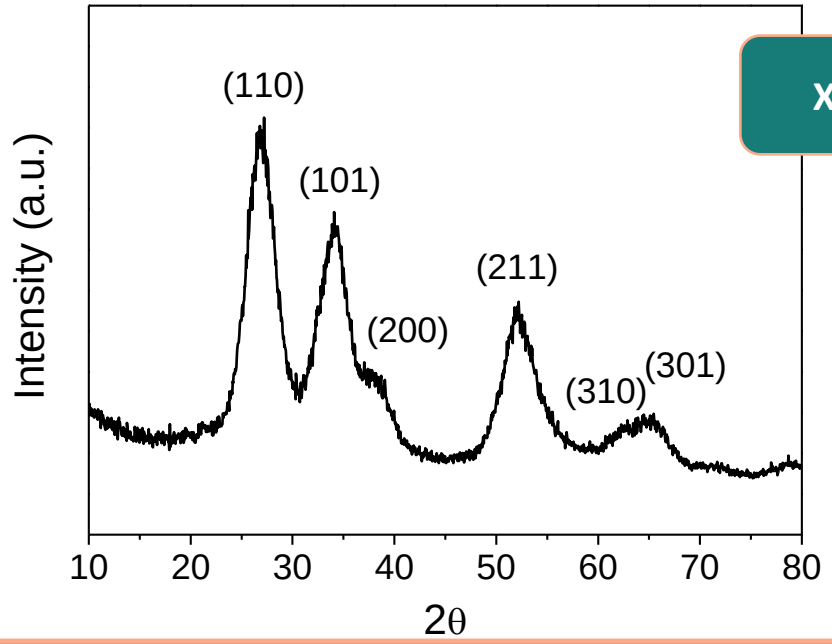
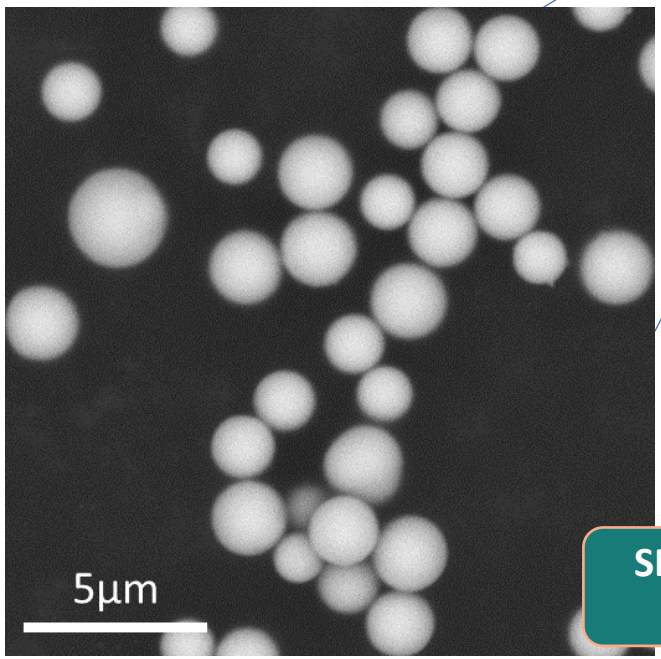
SnO_2 preparation and characterization

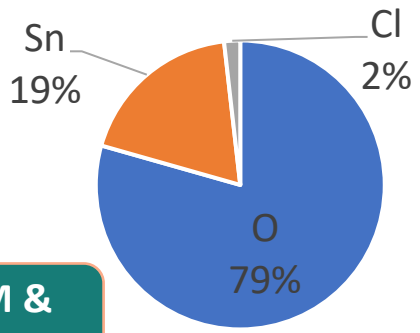
Hydrothermal process



XRD







SEM & EDS

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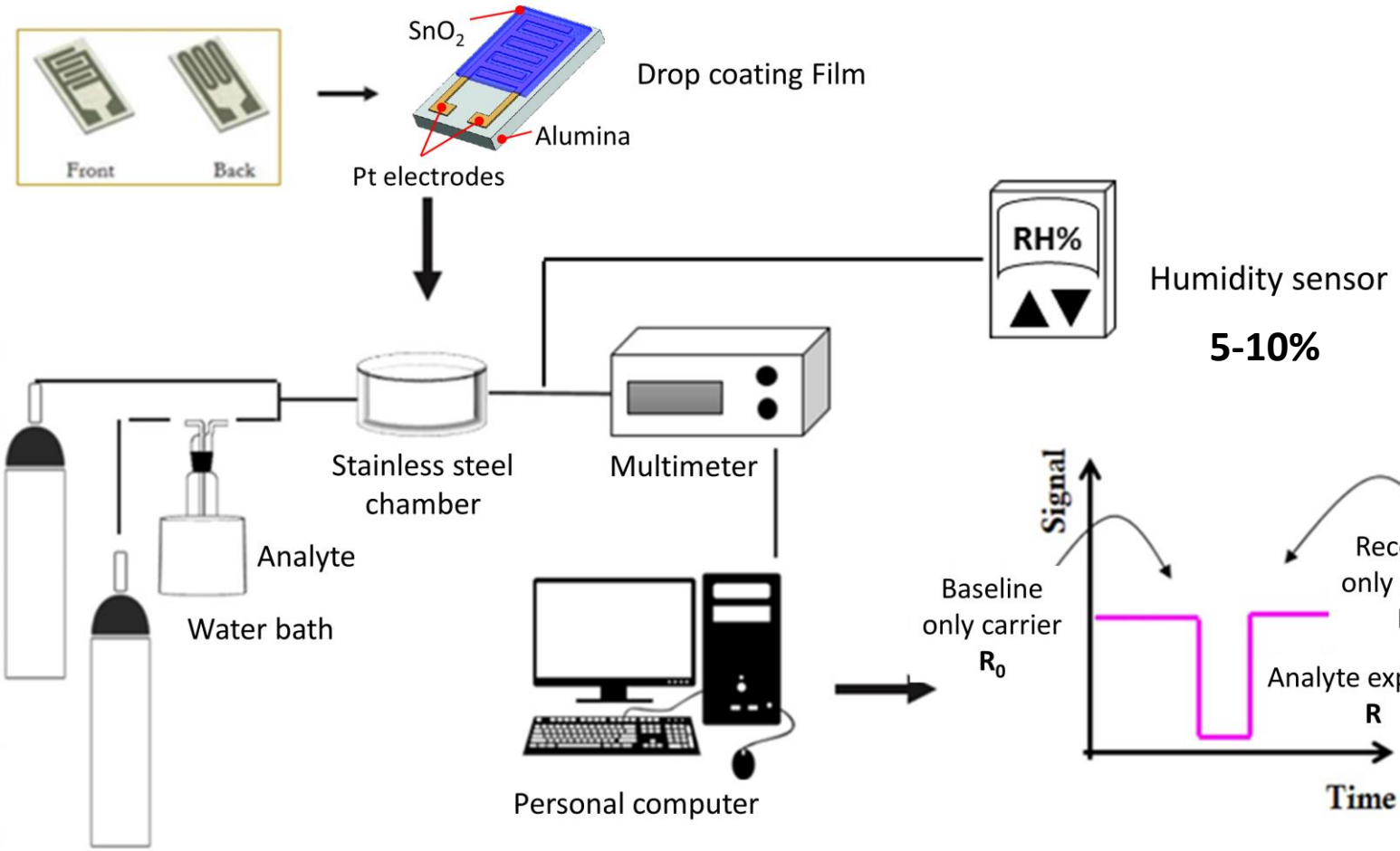
Working Conditions

Sensor Temperature: 200°C



Carrier	Analyte		
	Diacetyl (mg/l)	EtOH (%)	EtOH+Diacetyl (%;mg/l)
Air	0.4	5	5; 0.4
N2	0.4	5	5; 0.4
CO2	0.05|0.2|0.4|1.6|0.4	5	5; (0.4|0.8|1.6|3.2)
CO2-Air 25/75	0.4	5	5; 0.4

Notation

$R > R_0$ $\quad S = R/R_0$

$R < R_0$ $\quad S = R_0/R$

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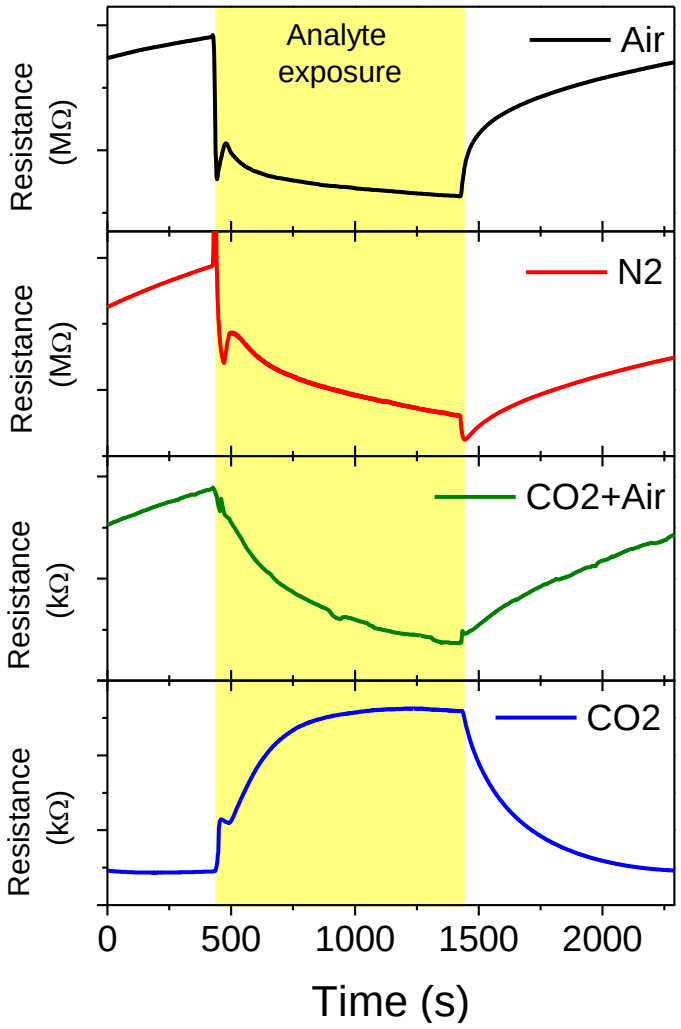
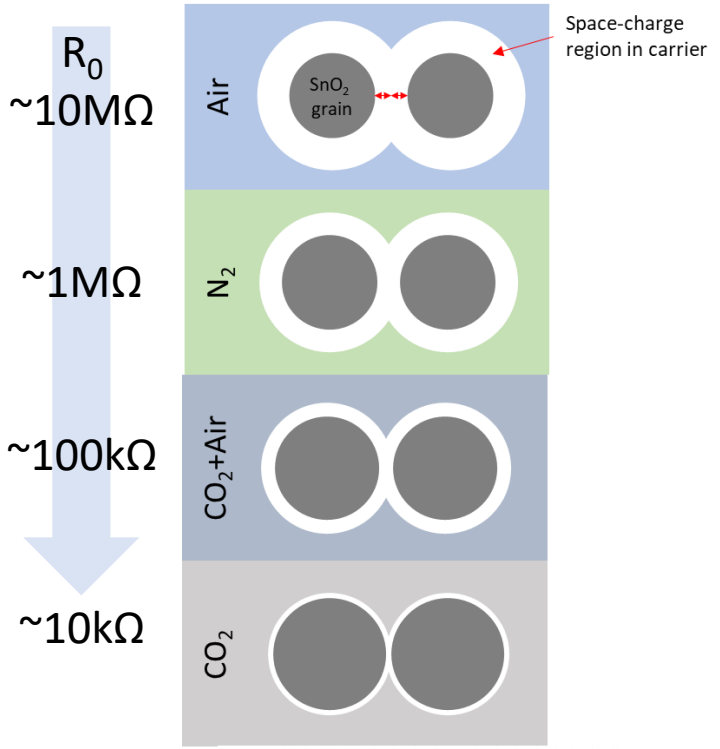
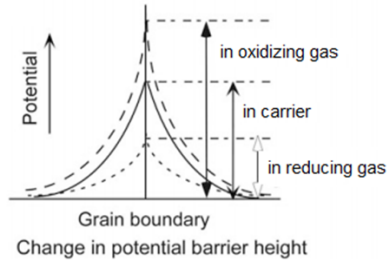
Diacetyl sensing in different atmospheres







Diacetyl concentration: 0.4mg/l

Carrier	Behaviour	R/R0
Air	Ox	1.43±0.03
N2	Inert	1.60±0.03
CO_2+Air (25%-75%)	Red+Ox	1.16±0.02
CO_2	Red	1.13±0.01

CO_2 behaves as a donor of electrons, similar to a weak reducing gas

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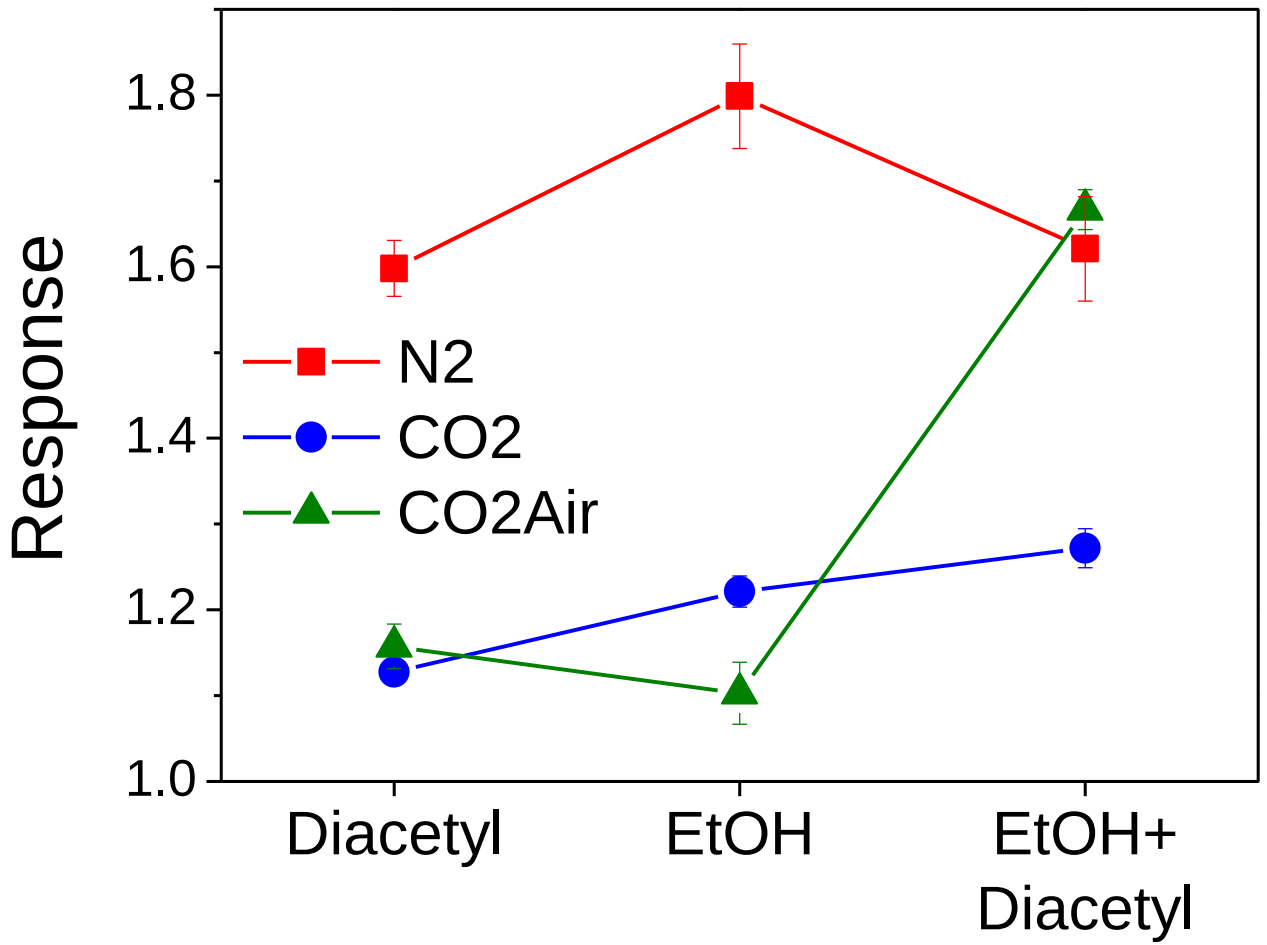
Ethanol-Diacetyl sensing



Sensor Temperature: 200°C
Ethanol concentration: 5%
Diacetyl concentration: 0.4mg/l

Carrier	R/R0		
	Diacetyl	EtOH	EtOH+Diacetyl
Air	1.43±0.03		
N2	1.60±0.03	1.80±0.06	1.62±0.06
CO2	1.13±0.01	1.22±0.02	1.27±0.02
CO2+Air	1.16±0.03	1.10±0.04	1.67±0.02

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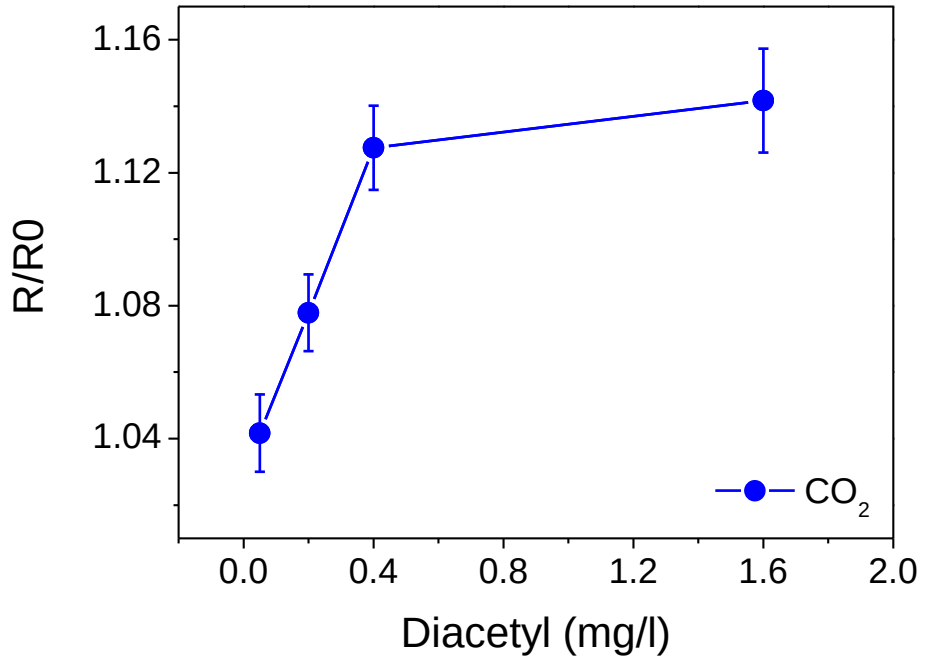
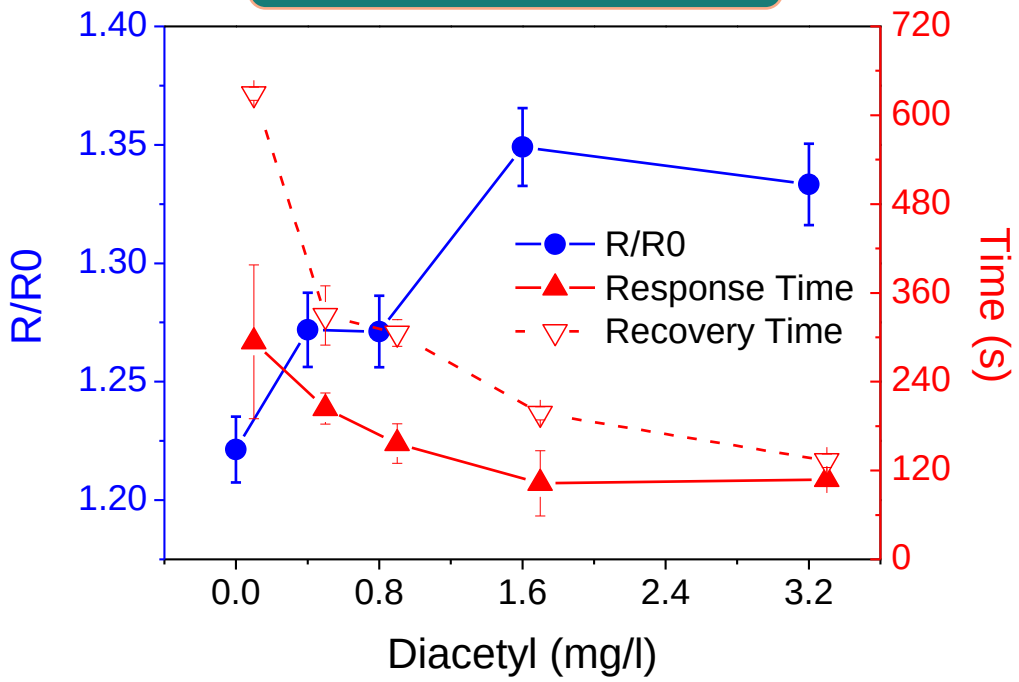
Diacetyl and Diacetyl-Ethanol solutions at different concentrations in CO_2

H_2O+Diacetyl



Diacetyl (mg/l)	R/R0
0.05	1.04 ±0.01
0.2	1.08 ±0.01
0.4	1.13 ±0.01
1.6	1.14 ±0.02

H_2O+5%EtOH+Diacetyl



EtOH+Diacetyl (%; mg/l)	R/R0	Response Time (s)	Recovery Time (s)
5; 0	1.22±0.01	293± 104	629± 9
5; 0.4	1.27±0.02	204± 21	330± 40
5; 0.8	1.27±0.02	156± 27	306± 18
5; 1.2	1.35±0.02	103± 44	197± 9
5; 3.2	1.33±0.02	108± 7	133± 9

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CONCLUSIONS

- **Tin oxide** showed promising sensing characteristics toward volatile flavour compounds, such as **diacetyl**
- **Different atmospheres** were evaluated
- SnO_2 works as **p-type** sensor in CO_2 atmosphere
- Sensor response **increases** with diacetyl concentration in aqueous and 5% ethanol aqueous solutions
- Evaluating **response** and **response and recovery times** can be possible to detect diacetyl concentration in solutions with fixed percentage of ethanol

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Thank you for your attention!!

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