# Elucidation of Heterogeneous Catalytic Nanostructures Using "Surface-Sensitive" Techniques at the Molecular Level


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Ozensoy Research Group

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- *Aybegüm Samast*
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- *Mustafa Çağlayan*

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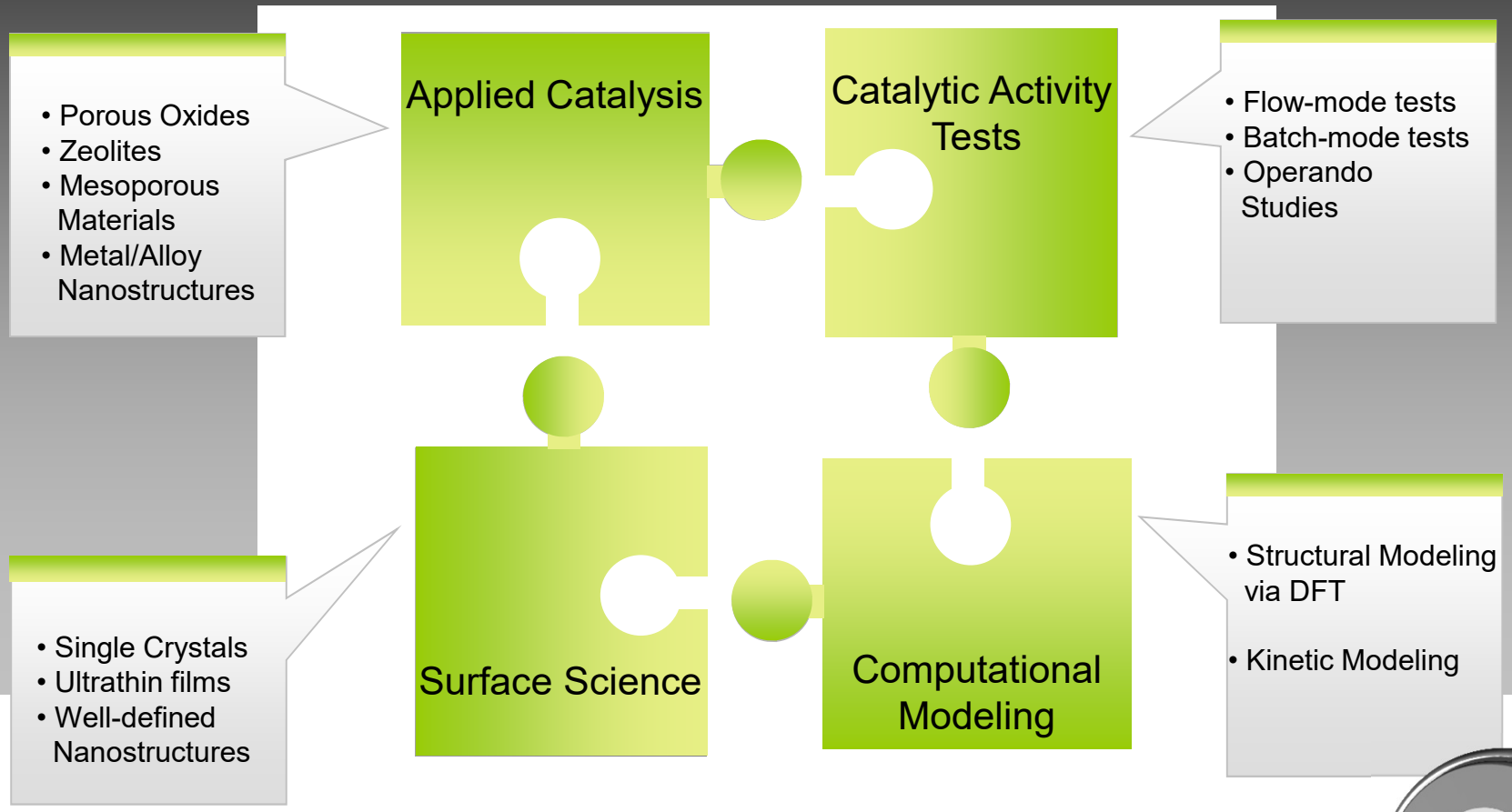
# Attacking the Problem from Multiple Fronts: Catalysis Research via Various Perspectives




***Nanostructure vs. Catalytic Functionality***

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# Problems of Interest & Potential Fields of Collaboration: I

## Understanding the surface/electronic structure of $PdAg/MnO_x/TiO_2$-based bi-metallic/tri-metallic Formic Acid Dehydrogenation catalysts

$$HCOOH \rightarrow H_2 + CO_2$$
$$HCOOH \rightarrow H_2O + CO$$


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# Record High Performance in Additive Free-Heterogeneous Catalytic FA Decomp.

| Catalyst | Temperature (K) | Conversion (%) | Activity ($h^{-1}$) | Reference |
|---|---|---|---|---|
| Ag@Pd | 293 | 36 | 63 | 1 |
| AgPd | 293 | 10 | 72 | 1 |
| Au@Pd | 298 | 89 | 98 | 2 |
| CoAuPd/C | 298 | 91 | 37 | 3 |
| CoAuPd/GO | 298 | 51 | 45 | 4 |
| CoAuPd/DNA | 298 | 96 | 85 | 5 |
| AuPd | 298 | 28 | 41 | 5 |
| AgPd | 298 | 52 | 110 | 6 |
| Pd-MnOx | 298 | 63 | 150 | 7 |
| PdAg-$MnO_x$/$NH_2$-$SiO_2$ | 298 | **> 99** | **330*** | ***this study*** |


[1] Tedsree, K. et al. ***Nature Nanotech. 2011***, 6, 302-307.
[2] Wang, Z. L. et al. ***J. Mater. Chem. A 2013***, 1, 12721-12725.
[3] Wang, Z. L. et al. ***Angew. Chem. Int. Ed. 2013***, 52, 4406.
[4] Wang, Z. L. et al. ***Chem. Commun. 2014***, 50, 2732-2734.
[5] Metin, O. et al. ***Nanoscale 2013***, 5, 910-912
[6] Zhang, H. et al. ***Angew. Chem. Int. Ed. 2013***, 52, 3681-3684.
[7] Bulut, A. et al. ***Applied. Catal. B: Env. 2015***, 164, 324-333.


Bulut and Ozensoy et al. ***ACS Catalysis*, 2015**.


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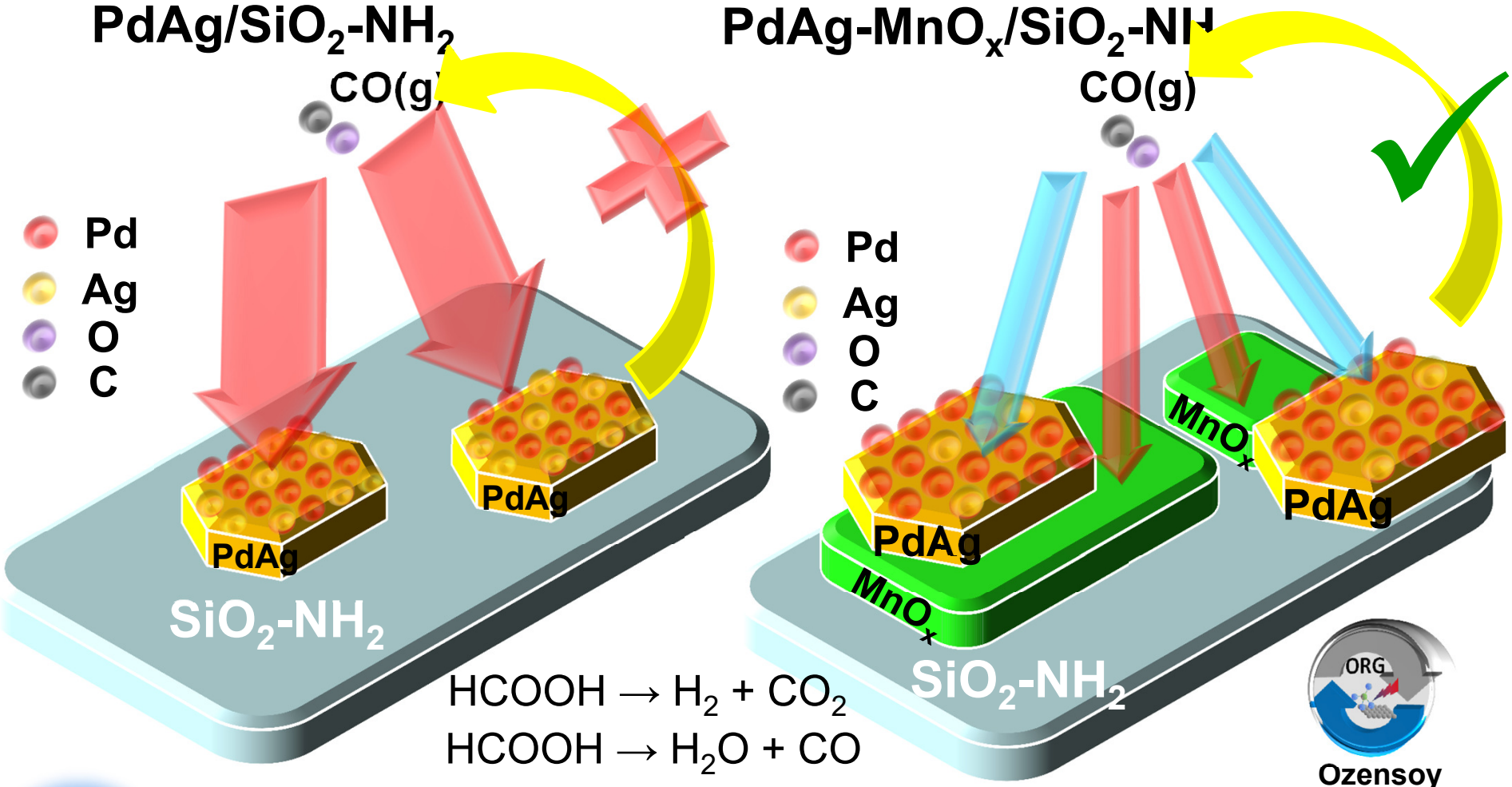
# Operational Mechanism of PdAg-NP




$$HCOOH \rightarrow H_2 + CO_2$$

$$HCOOH \rightarrow H_2O + CO$$

Bulut & Ozensoy et al. ***ACS Catalysis* 2015**

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$MnO_x$-free (unpromoted)
PdAg Bimetallic Nanoparticle
Enriched with Ag on the Surface
Prone to CO Poisoning

$MnO_x$-promoted
PdAg Bimetallic Nanoparticle
Enriched with Pd on the Surface
Resilient Against CO Poisoning

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# Problems of Interest & Potential Fields of Collaboration: II

## Shedding light on the surface functional groups of novel graphene-like photocatalysts that can be activated via VIS light

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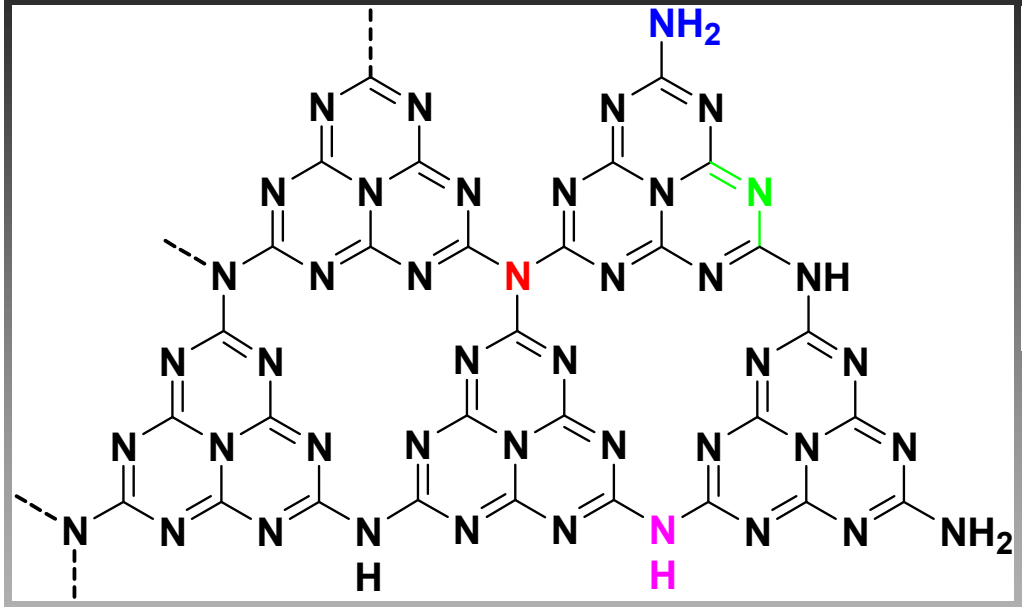
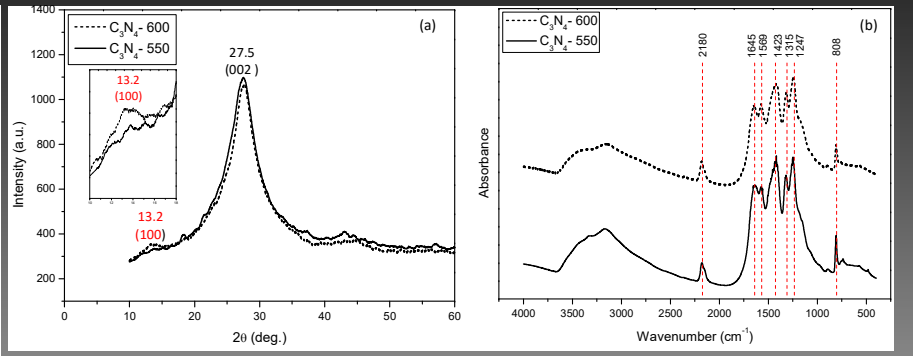
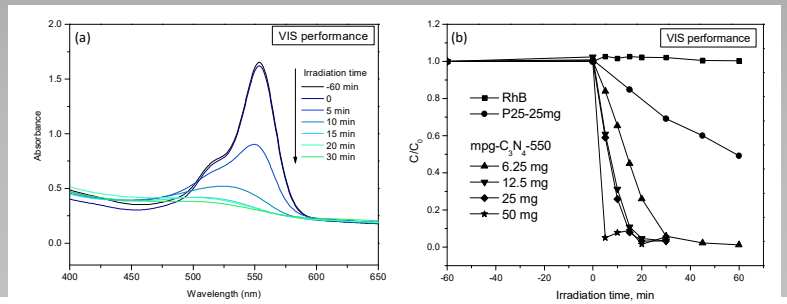
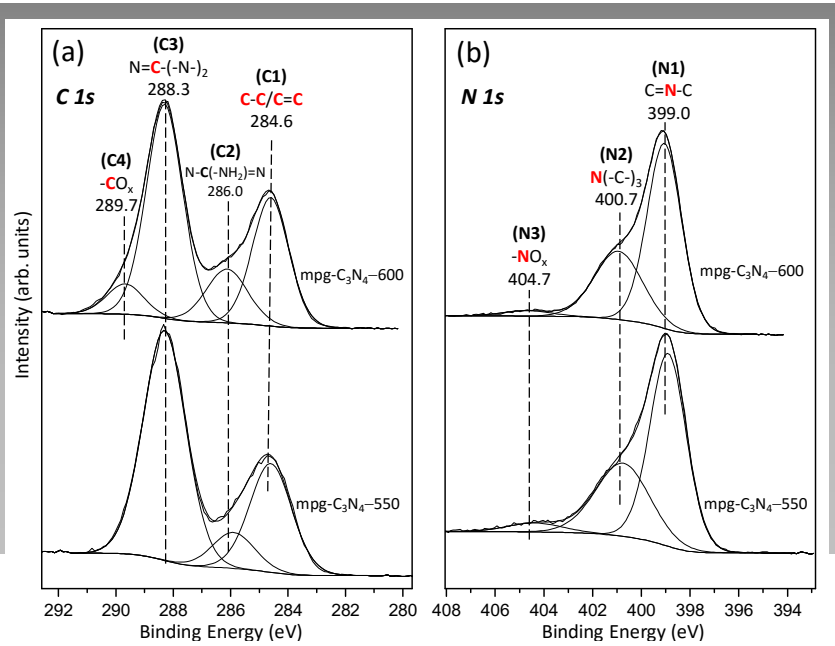
# Mpg-$C_3N_4$: Superior Photocatalyst under VIS Light




**Erdogan & Ozensoy et al. 2016, submitted.**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# Problems of Interest & Potential Fields of Collaboration: III

## Surface, electronic and coordination structure of $LaCo_{3-x}Mn_xO_{3\pm y}$ -based mixed perovskite catalysts for $DeNO_x$ applications.


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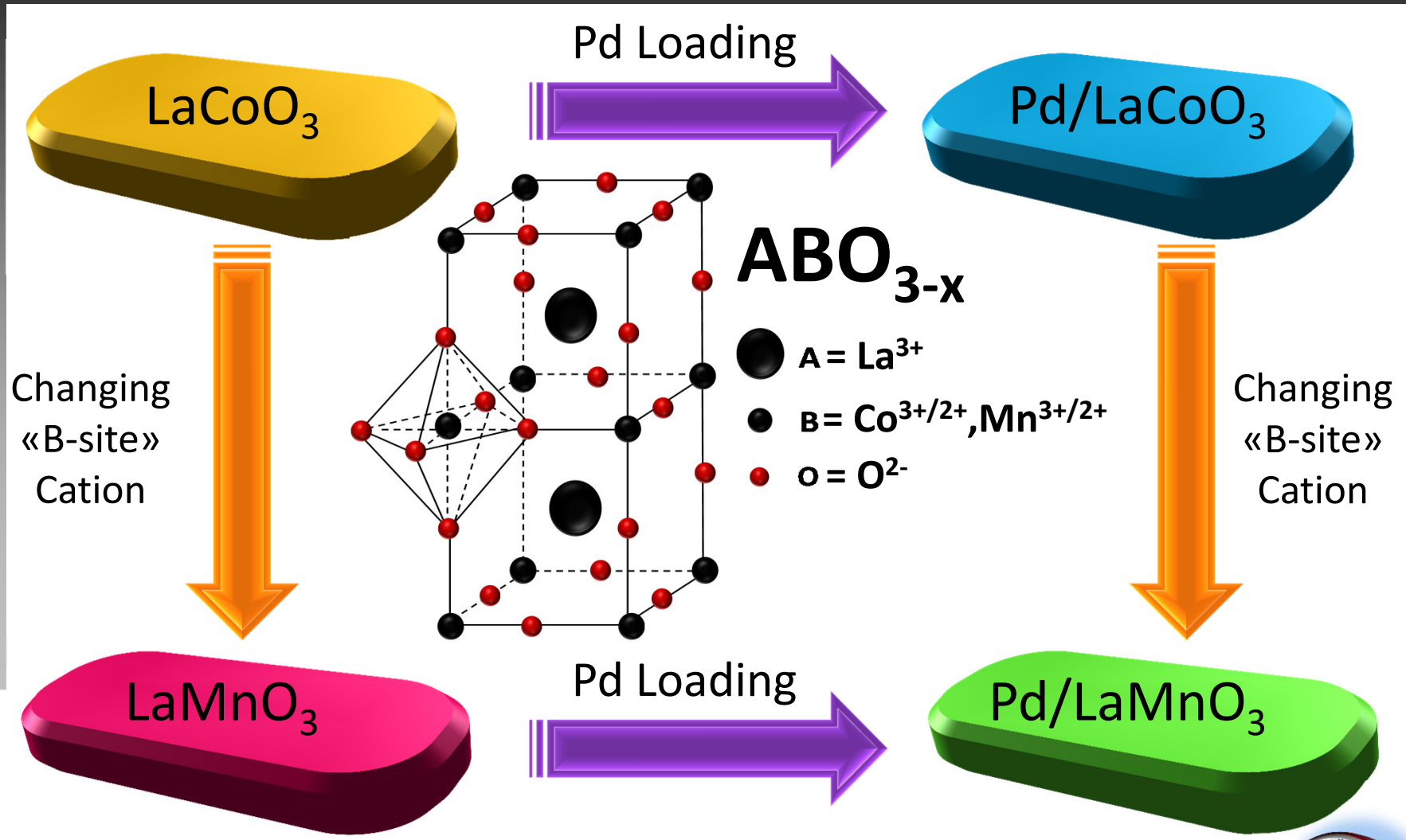
# Mn- and Co- based La-Perovskites





Say, Z.; Dogac, M.; Vovk, E.I.; Kalay, :E.; Kim, C. H.; Li, W..; Kalay, E.; **Ozensoy, E.** ***Applied Catal. B*, 2014** (154–155) 51–61.
Dogac, M.; Say, Z.; Vovk, E.I.; Kim, C. H.; E.; **Ozensoy, E.** ***, submitted,* 2016.**



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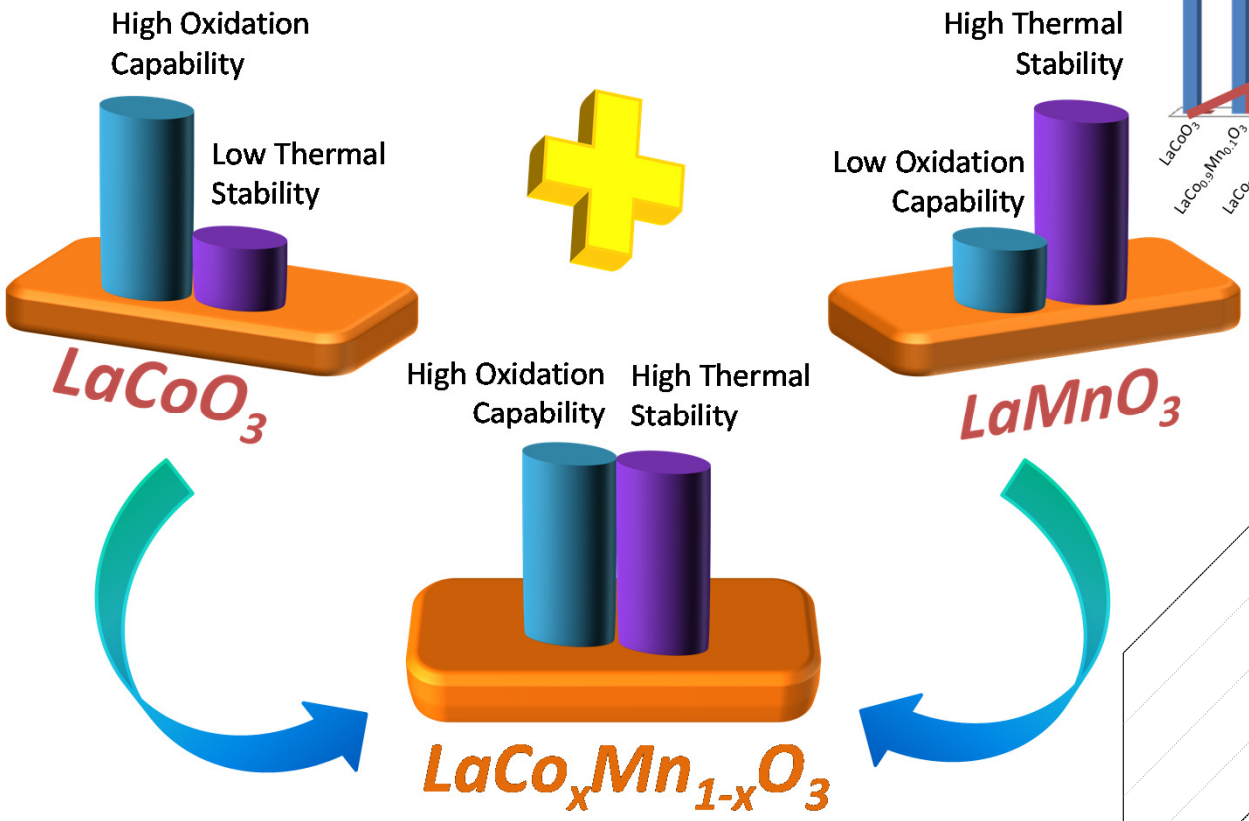
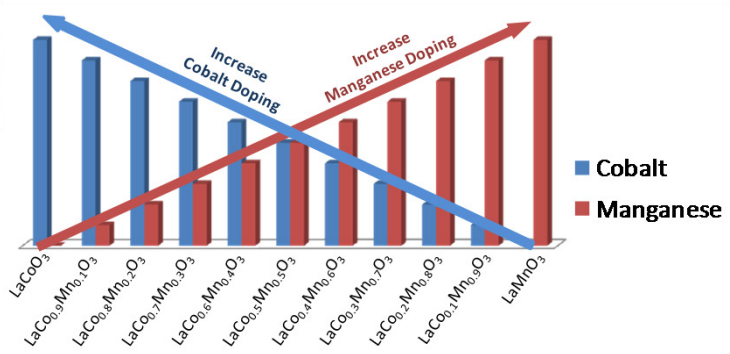
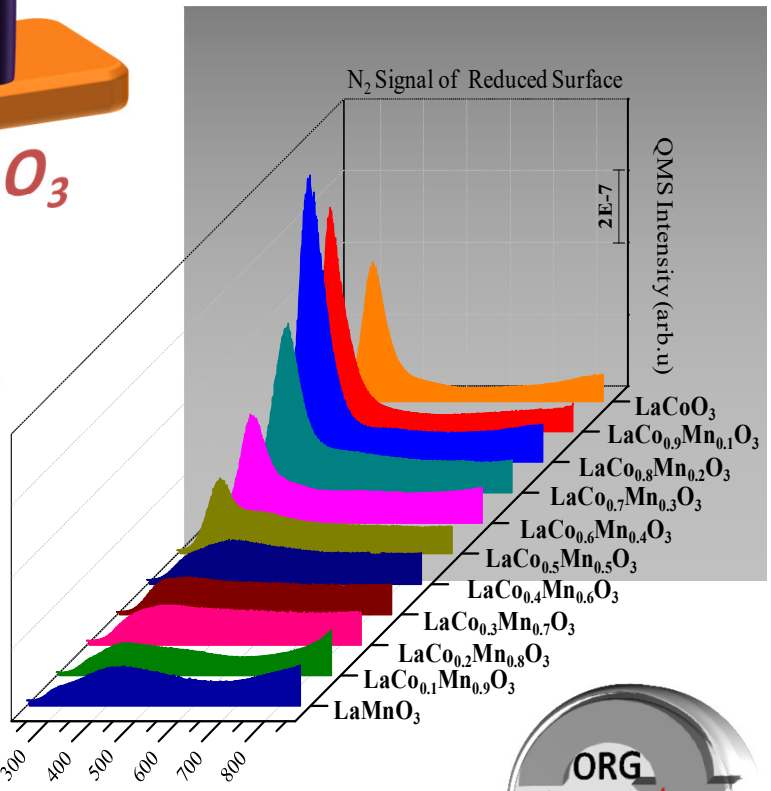
# Advanced Mixed Perovskite Structures for $DeNO_x$ Catalysis





Say, Z.; Dogac, M.; Vovk, E.I.; Kalay, :E.; Kim, C. H.; Li, W..; Kalay, E.; **Ozensoy, E.** ***Applied Catal. B*, 2014** (154–155) 51–61.
Dogac, M.; Say, Z.; Vovk, E.I.; Kim, C. H.; E.; **Ozensoy, E.** **, *submitted,* 2016.**



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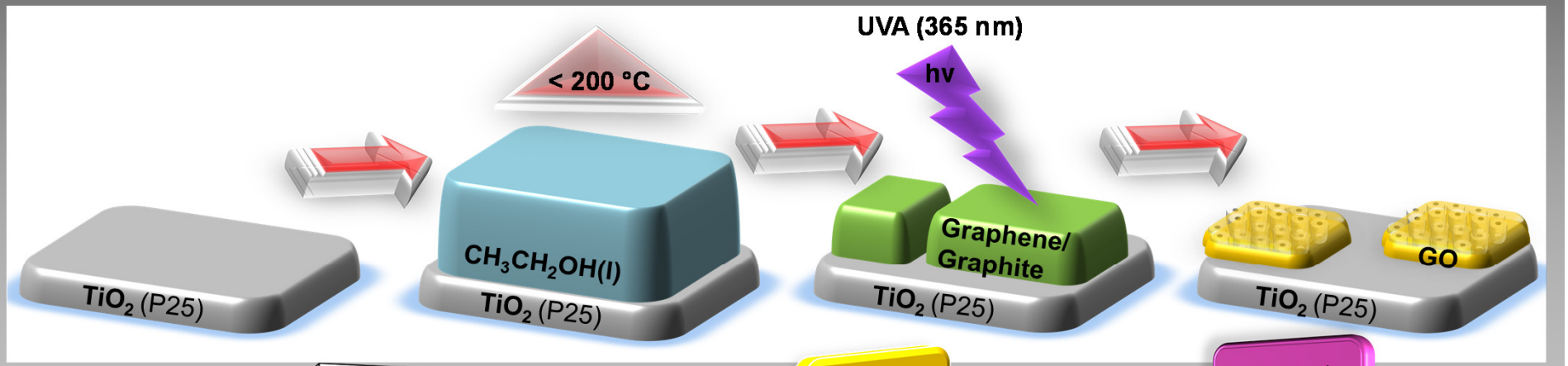
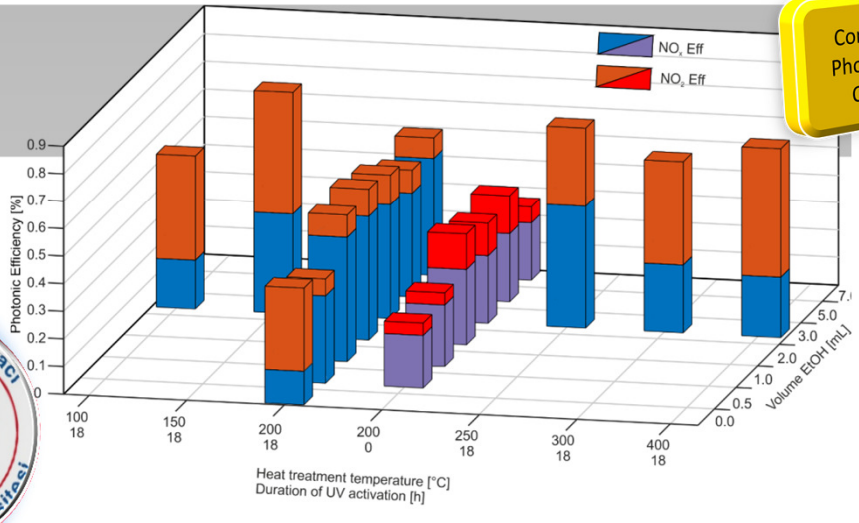
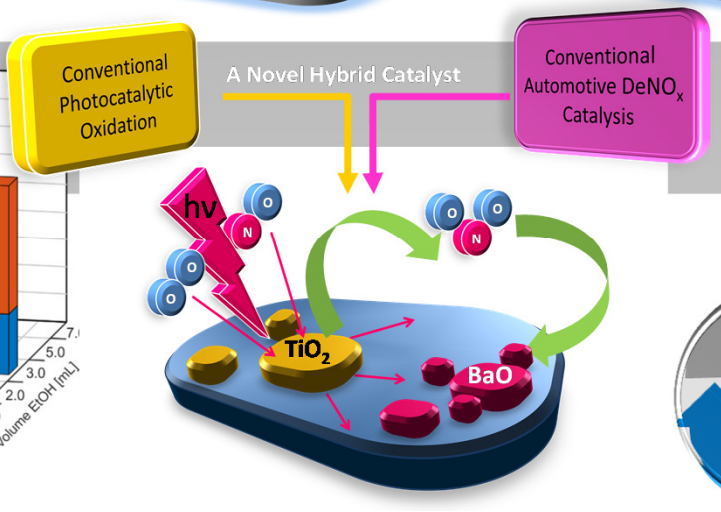
# Problems of Interest & Potential Fields of Collaboration: IV

## Self-Generating Photocatalytic Architectures





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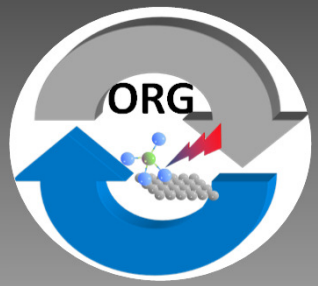
# Acknowledgements

## Sponsors & Collaborators

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**DESY, Germany**