One-Pot Synthesis of Mesoporous Cobalt Phosphate Used as a Catalase-like Nanozyme

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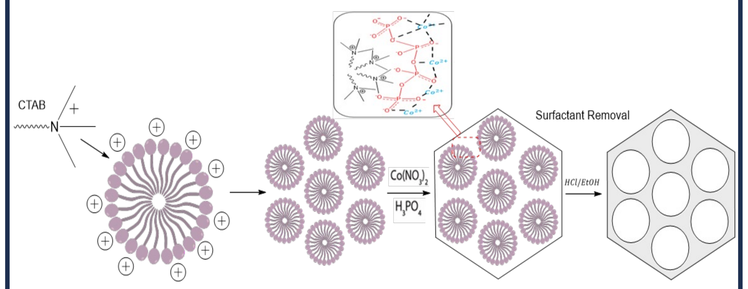
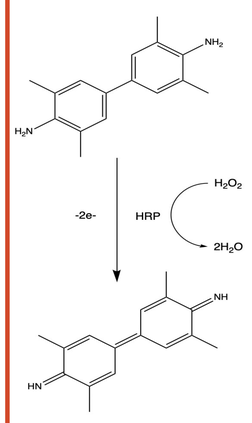
Introduction

- One pot systems are more efficient as they remove the need to isolate intermediates.
- Using catalytically active mesoporous nanomaterials as enzyme supports can enhance the performance of chemoenzymatic tandem systems.
- Using enzyme mimics (nanozymes) over enzymes has benefits such as nanozymes being lower in cost and being able to be used in a range of temperatures and pH values.

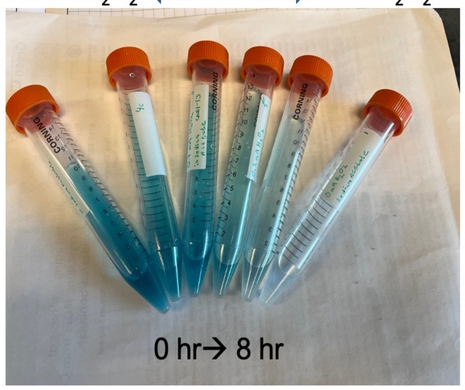
Synthesis of Bulk CoP_i and $mCoP_i$



Testing Bulk CoP_i and $mCoP_i$ as Catalase-mimics

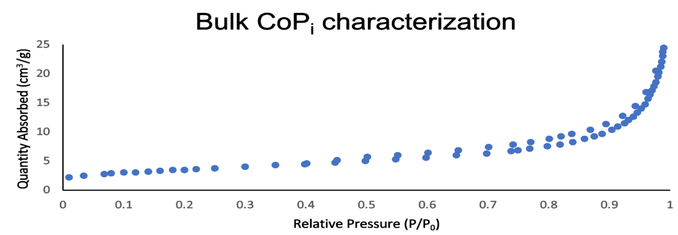


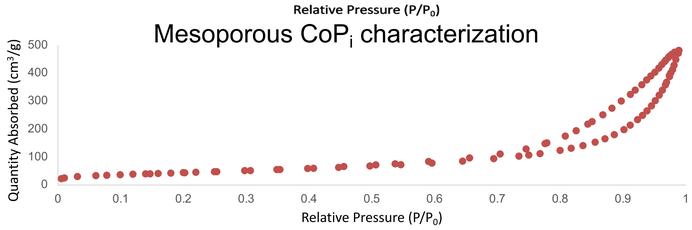
More H_2O_2 ⟷ Less H_2O_2



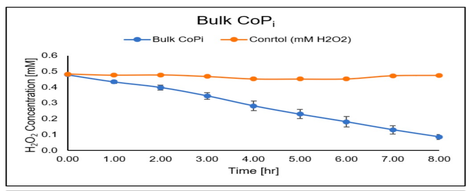
Results

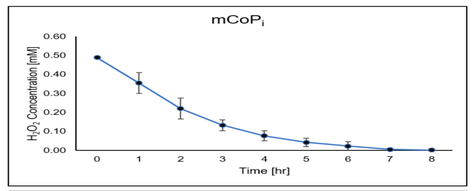
Nitrogen Sorption Isotherm data for Bulk CoP_i and $mCoP_i$:

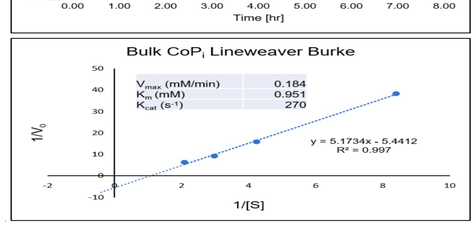


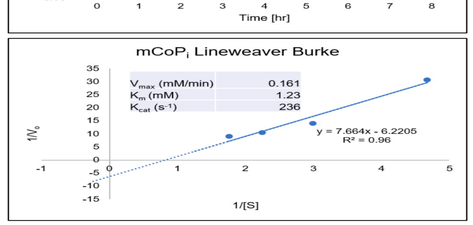


Catalase-like Kinetics Data for Bulk CoP_i and $mCoP_i$

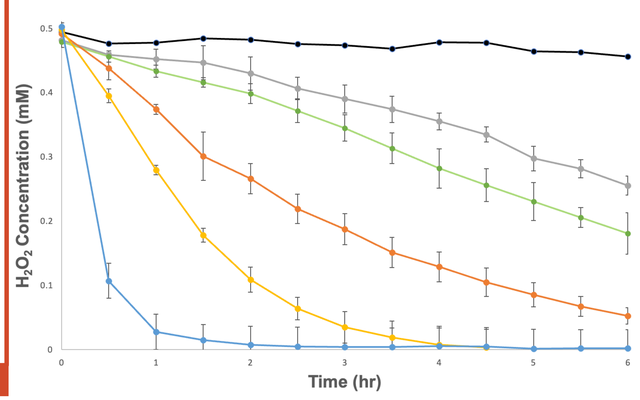






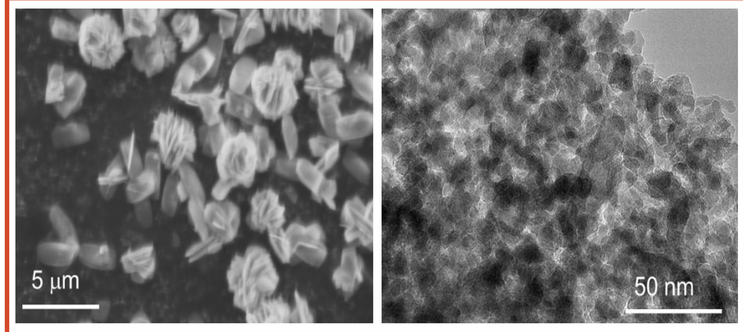


Michalis-Menten Kinetics Data:



= Control	Surface Area (m^2/g)
bCoP 4°C Synthesis -5°C Aging (Nanoflakes)	9.2
bCoP 27°C Synthesis 1°C Aging (Smaller Nanoflowers & Nanoflakes)	15.6
bCoP 1°C Synthesis 1°C Aging (Larger Nanoflowers)	26.0
mCoP 1°C Synthesis 1°C Aging	71.2
mCoP 1°C Synthesis -5°C Aging	207

SEM and TEM Images of Bulk CoP_i and $mCoP_i$

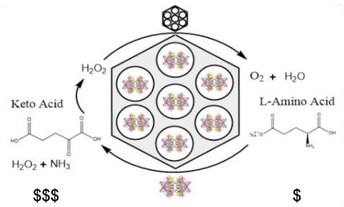


Discussion and Conclusions

- Characterization data confirms the creation of mesoporous cobalt phosphate and its ability to act as a catalase-like nanozyme.
- $mCoP_i$ has a larger substrate affinity (larger smaller K_m) than the bulk $mCoP_i$ attributed to a higher surface area and thus more catalase active sites. However, the bulk CoP_i has a larger Vmax and K_{cat} than the $mCoP_i$. This is because the bulk CoP_i was more suspended in H_2O_2/HEPES solution than the denser $mCoP_i$. Due to greater distribution throughout the solution, the bulk $mCoP_i$ could react with more substrate in a shorter amount of time.

Continuing Work

- Explore same synthesis conditions but with Pluronic surfactants.
  - Larger pore diameters (P123, F127).
- Retrieve detailed kinetics data for mesoporous materials and compare under similar conditions.
  - In addition, looking at other kinetics methods and comparing them to Michalis-Menten Kinetics.
- Covalently immobilize LGOX and LAAO into the $mCoP_i$ materials and test tandem system.



References

1. Metzger, K. E., Moyer, M. M., & Trewyn, B. G. Tandem catalytic systems integrating biocatalysts and inorganic catalysts using functionalized porous materials. ACS Catal, 2021, 11, 110-122.
2. Xu, D., Wu, L., Yao, H., & Zhao, L. Catalase-like nanozymes: Classification, catalytic mechanisms, and their applications. Small, 2022, 18, 37, 2203400.

Acknowledgements

- Trewyn Research Group
Department of Chemistry
- National Institutes of Health