RATIONAL SYNTHESIS OF Pt ICOSAHEDRAL NANOCRYSTALS WITH A CONTROLLABLE SIZE AND HIGH QUALITY

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CREATING THE NEXT®

Southeastern Undergraduate Internship in Nanotechnology, NSF EEC-1757579

Georgia Tech Institute for Electronics and Nanotechnology

PEM FUEL CELLS

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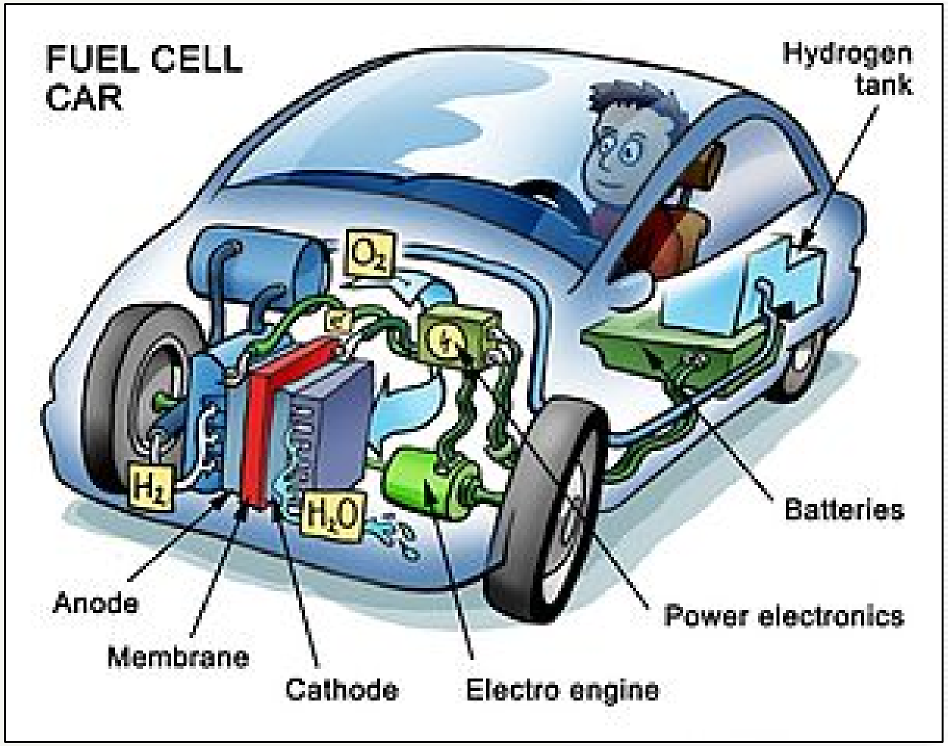
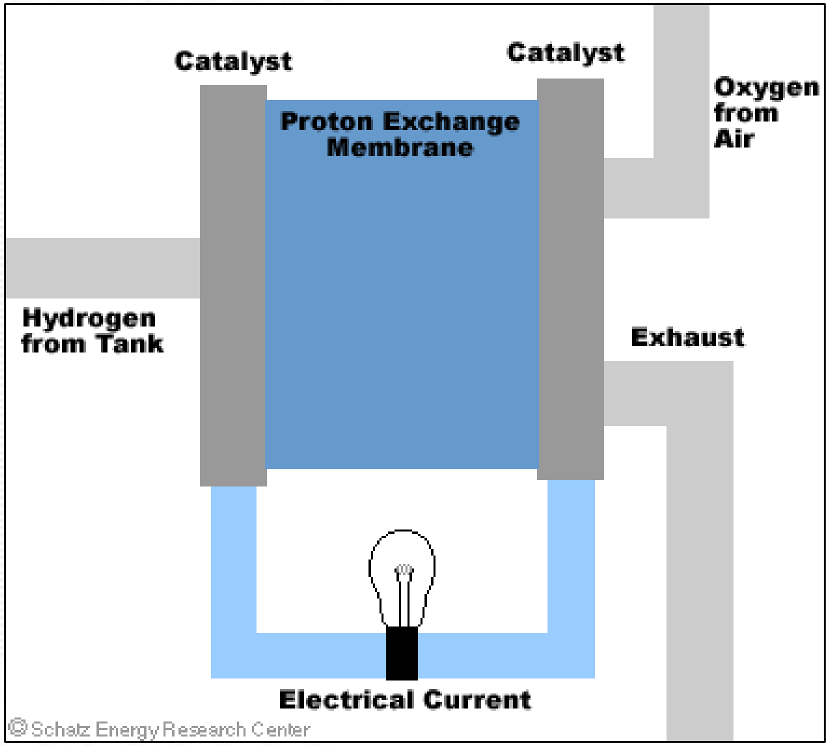
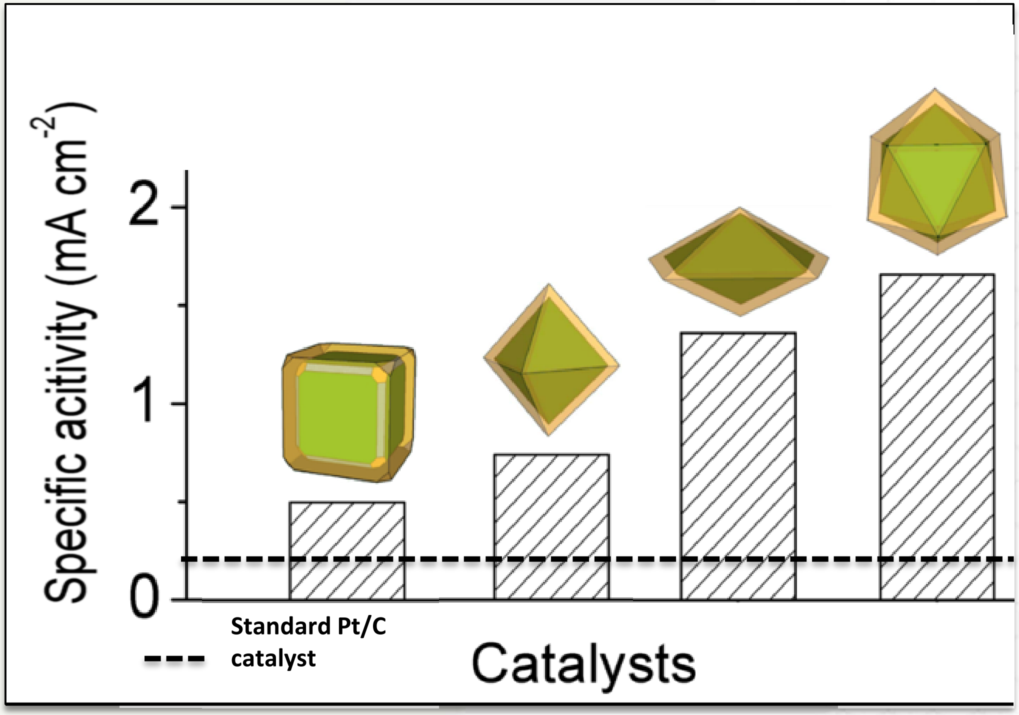




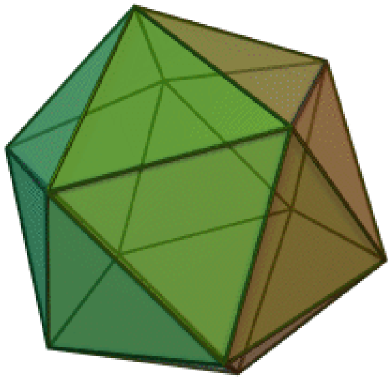
Proton Exchange Membrane Fuel Cell

Source: Google Images

ORR SHAPE-DEPENDENCE



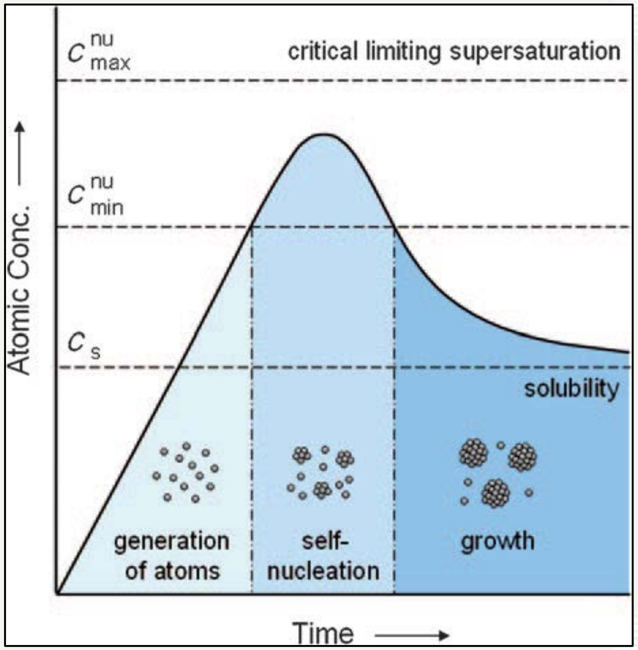
K. D. Gilroy et al. Adv. Mater. (2018)



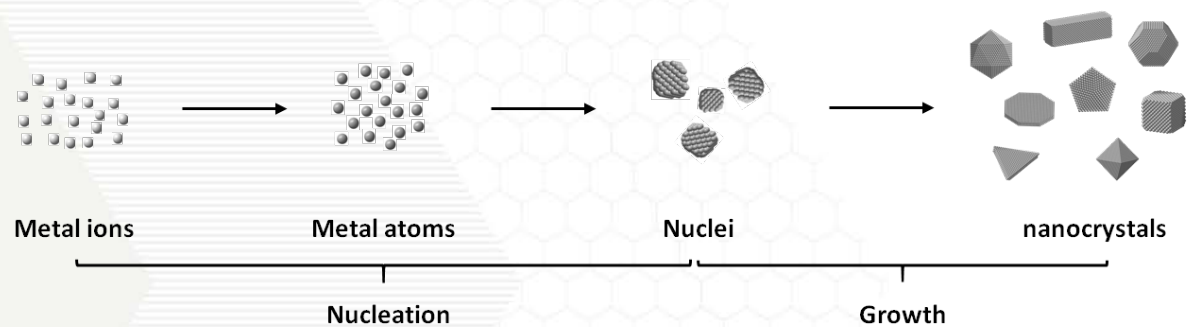
Source: Google Images

- {111} facets more active than {100}
- Presence of twin boundaries increases activity
- Higher density of twin defects increases activity

NUCLEATION AND GROWTH

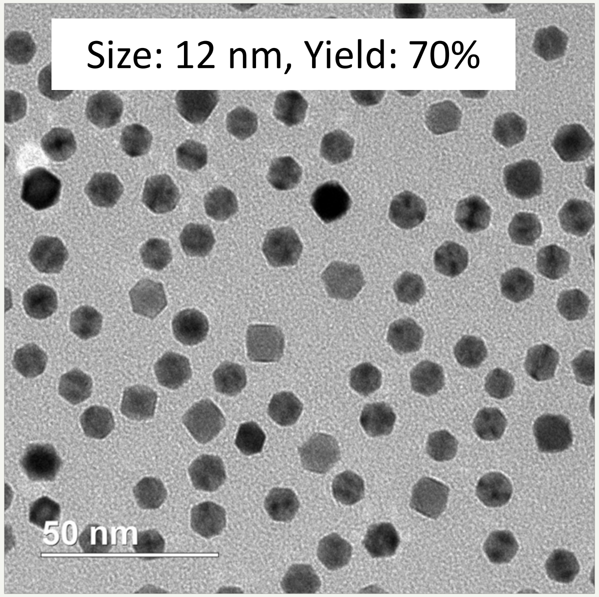


Y. Xia et al. Angew. Chem. Int. Ed. (2009)

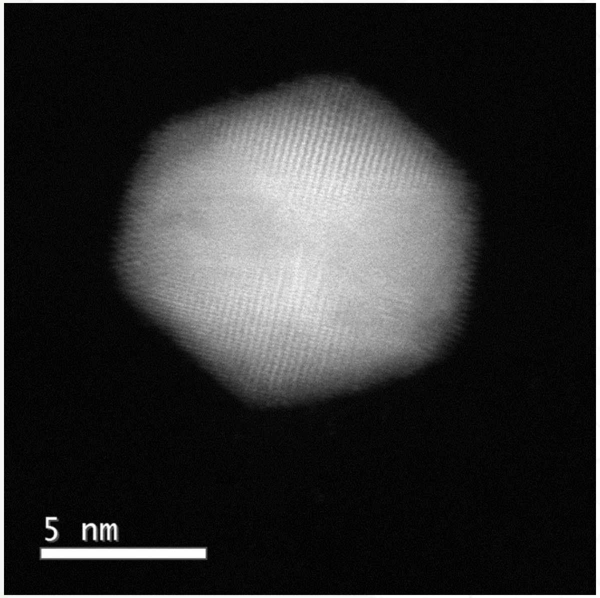


- Synthesis uses homogeneous nucleation
- $Pt(acac)_2$ used as metal precursor
- Tetraethylene Glycol (TTEG) and Ascorbic Acid (AA) are reducing agents
- Polyvinyl Pyrrolidone (PVP) used as stabilizer

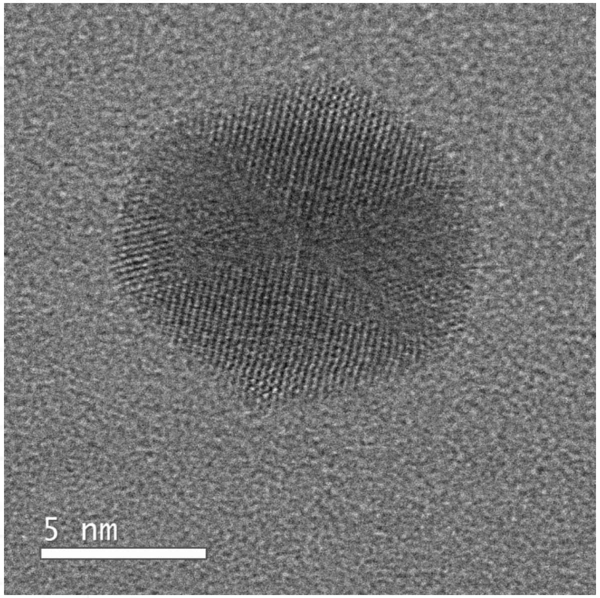
STANDARD SYNTHESIS



Best Pt icosahedral nanocrystals that could be achieved before this report.

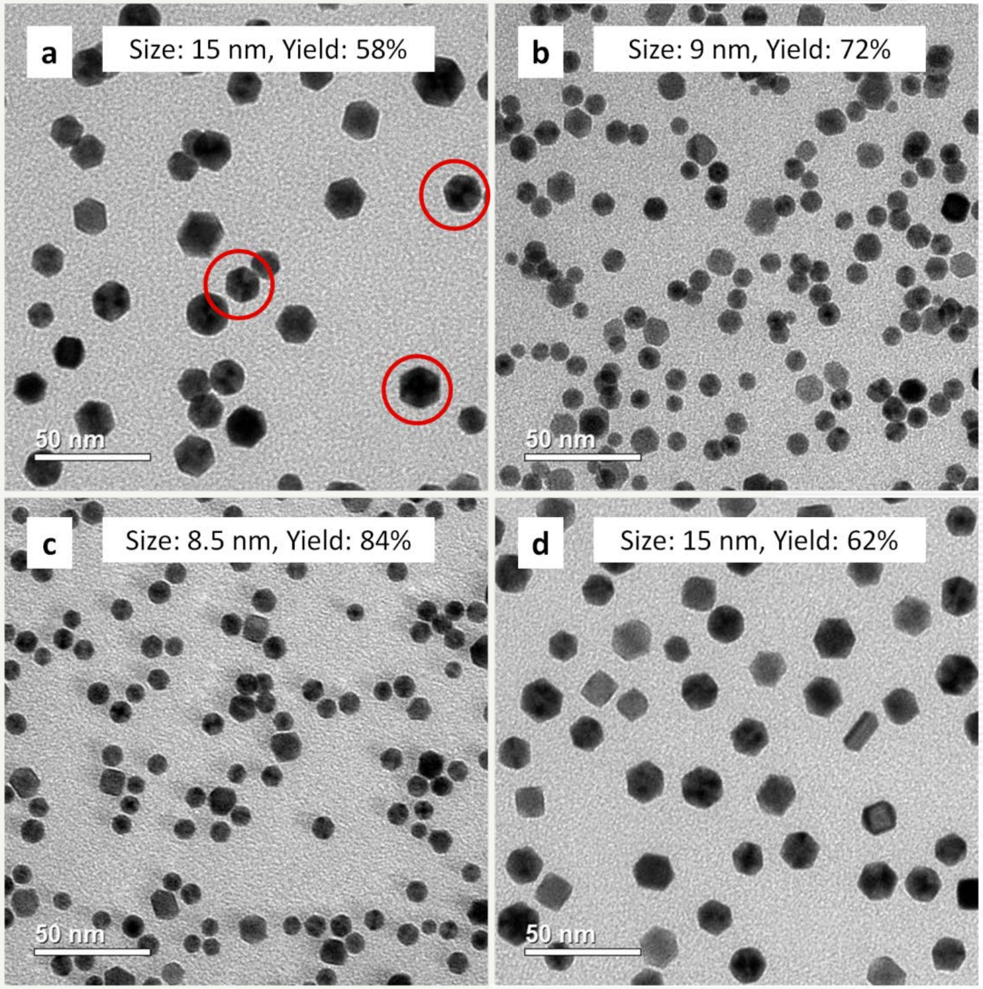


Dark Field HRTEM Image

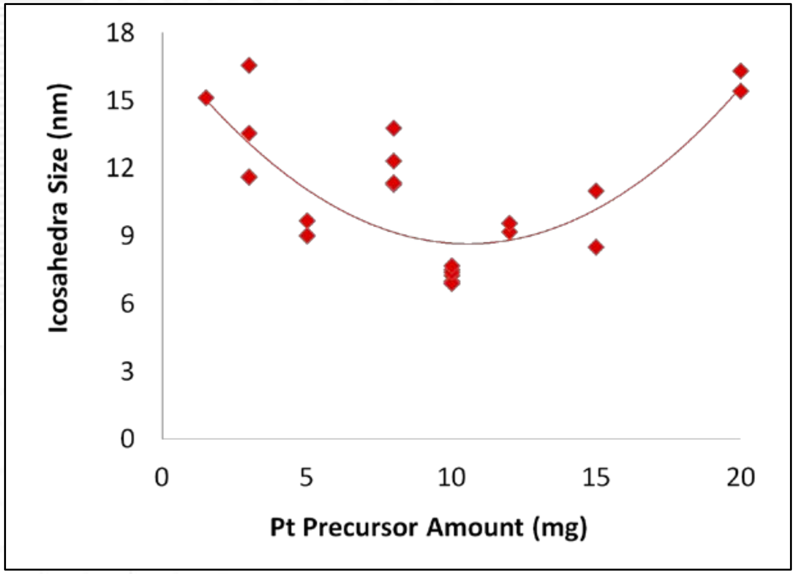


Bright Field HRTEM Image

RESULTS



(a) 1.5 mg Pt precursor
(b) 5 mg Pt precursor
(c) 10 mg Pt precursor
(d) 20 mg Pt precursor.



RESULTS

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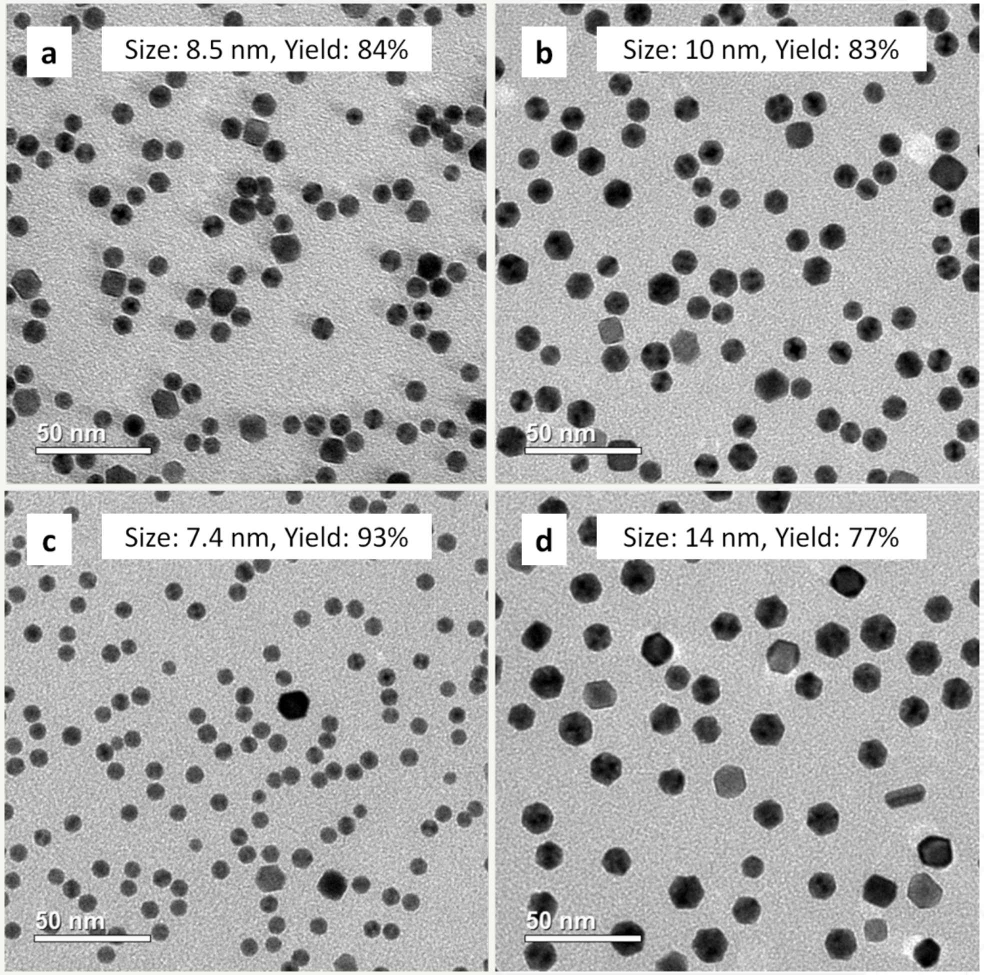
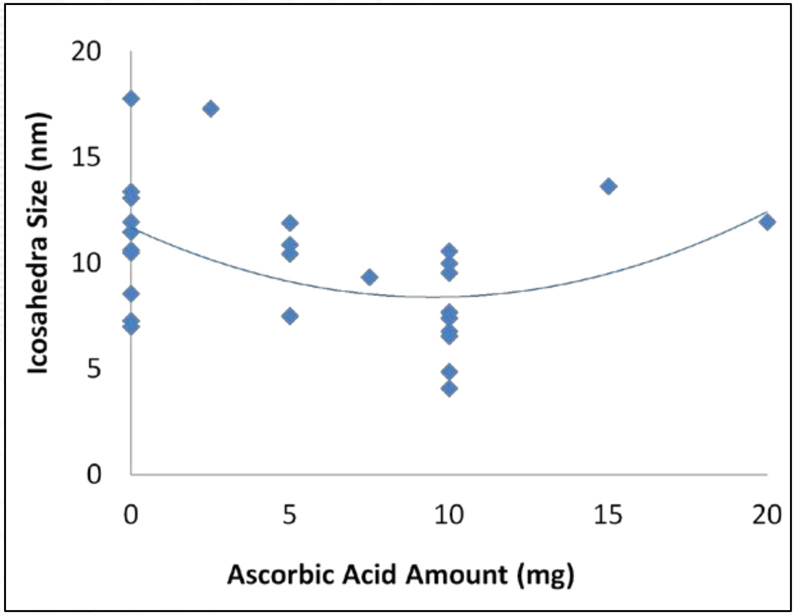


(a) 0 mg Ascorbic Acid (AA)
(b) 5 mg AA
(c) 10 mg AA
(d) 15 mg AA



CONCLUSIONS

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•By varying the amount of $Pt(acac)_2$ we were able to maneuver the nucleation of Pt atoms, leading to Pt icosahedral nanocrystals with a size ranging from 8-10 nm.

•Introduction of ascorbic acid (AA) accelerates the generation of more Pt nuclei during nucleation, thus producing Pt icosahedral nanocrystals with a size range down to 5-8 nm and a yield greater than 90%

FUTURE WORK

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- Investigation of boosted ORR activity of our Pt icosahedral nanocrystals
- HRTEM analysis of the formation mechanism of our Pt icosahedral nanocrystals
- Functionalization of Pt icosahedra in a PEMFC should also be studied.

QUESTIONS?