

Ultra-efficient, Robust and Well-defined Nano-Array based Monolithic Catalysts

Yanbing Guo, Zheng Ren, and Pu-Xian Gao

Department of Chemical, Materials and Biomolecular Engineering &
Institute of Materials Science
University of Connecticut, Storrs, CT 06269-3136

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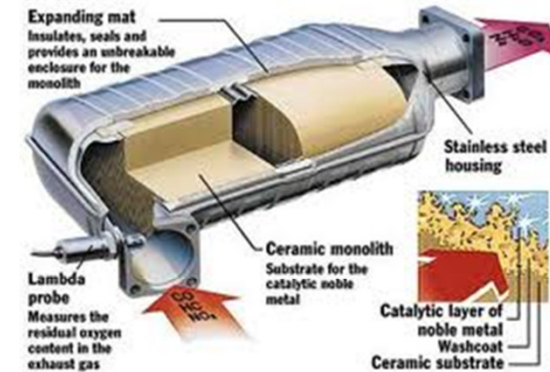
Outline

- 1 Nano-array based monolithic catalysts
- 2 Thermal and mechanical stability
- 3 Catalytic performance: CO oxidation
- 4 Conclusion
- 5 Acknowledgement

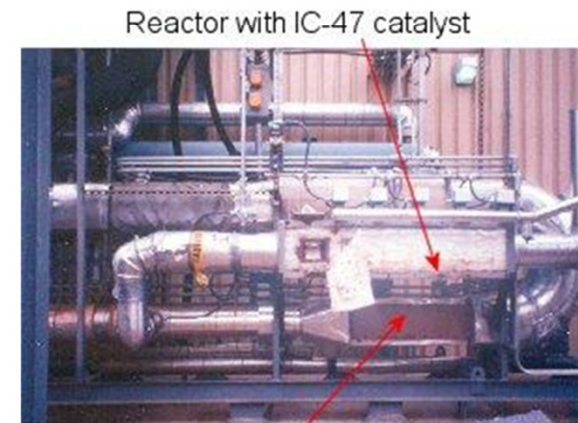
Motivations and Goals

❖ Challenges in emission control in vehicles, aircrafts and relevant combustion systems

- ❑ Inevitable use of precious metals (Pt, Rh, and Pd)
- ❑ Lack well-defined structural configurations
- ❑ Practical industrial catalysts' performance **VS** the origin of catalytic activity



- **Improve efficiency**
- **Reduce PGM usage**
- **Lower cost**

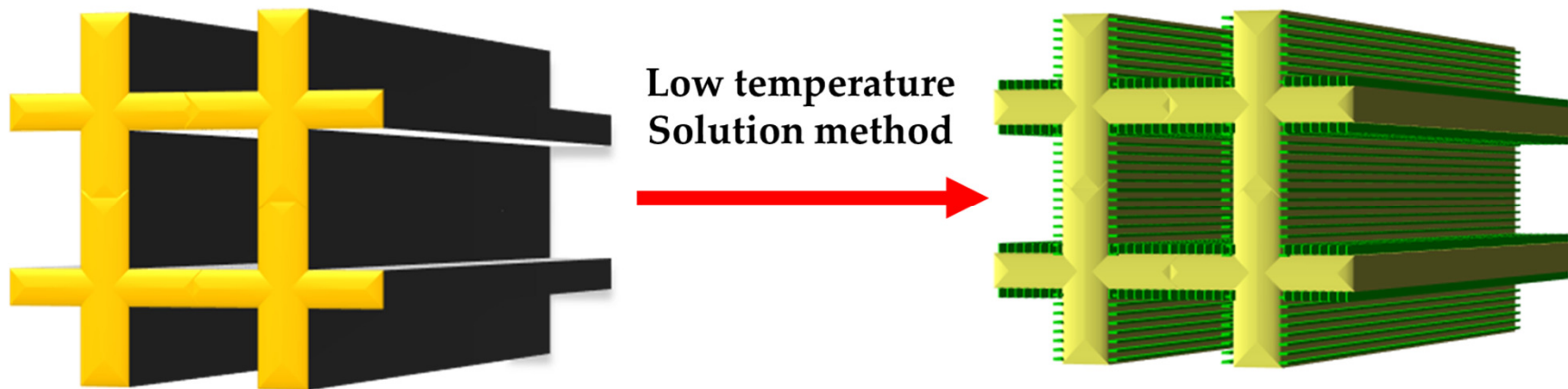


Images from:
<http://www.importcatalytic.com/>
http://en.wikipedia.org/wiki/Power_station
<http://www.made-in-china.com/showroom>

http://www.en.catalysis.ru/block/?print_version=ves&ID=19&SECTION_ID=1297

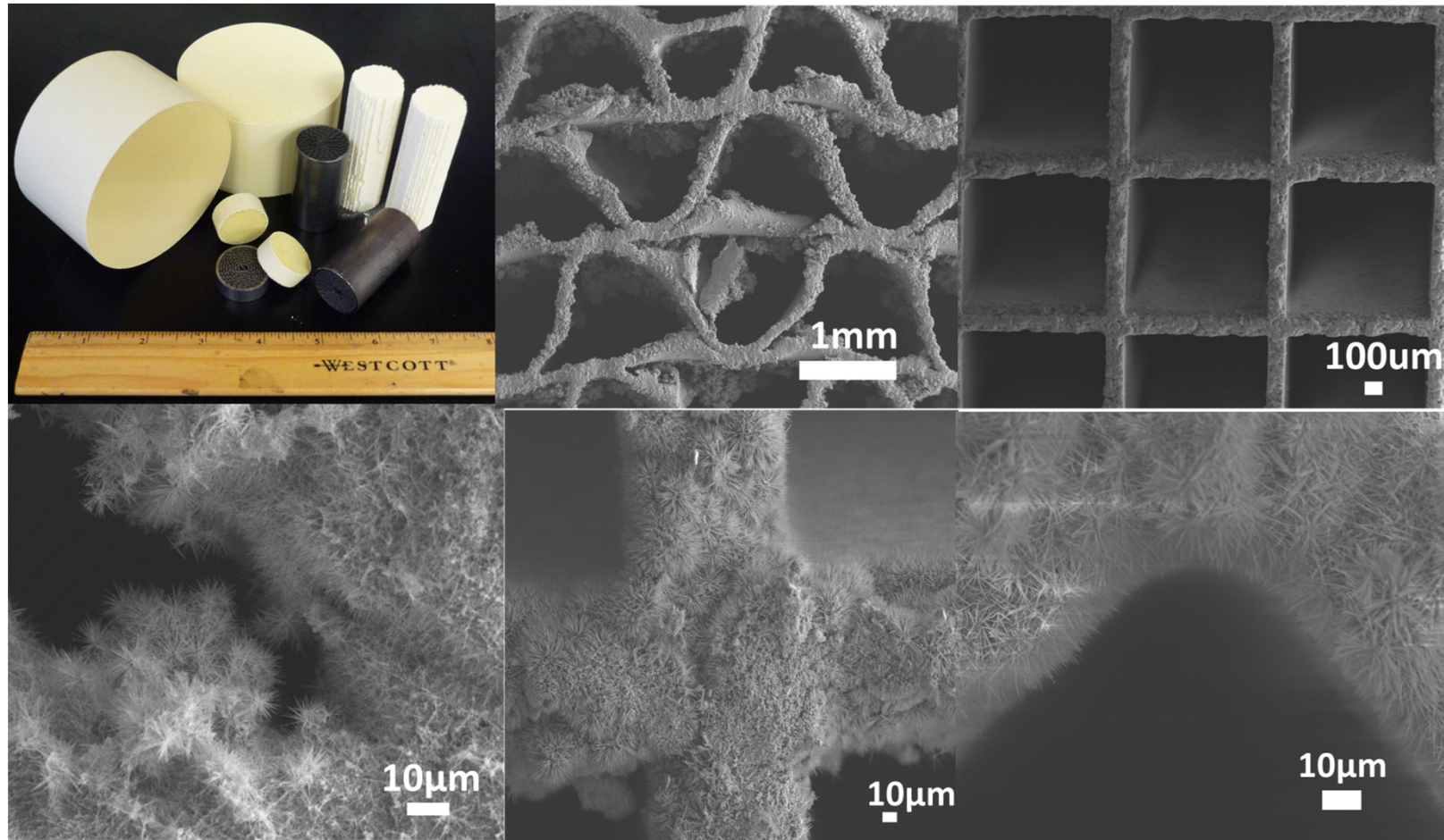
Catalysts Preparation

- In-situ growth of nano-array on monolith
- Free of binders



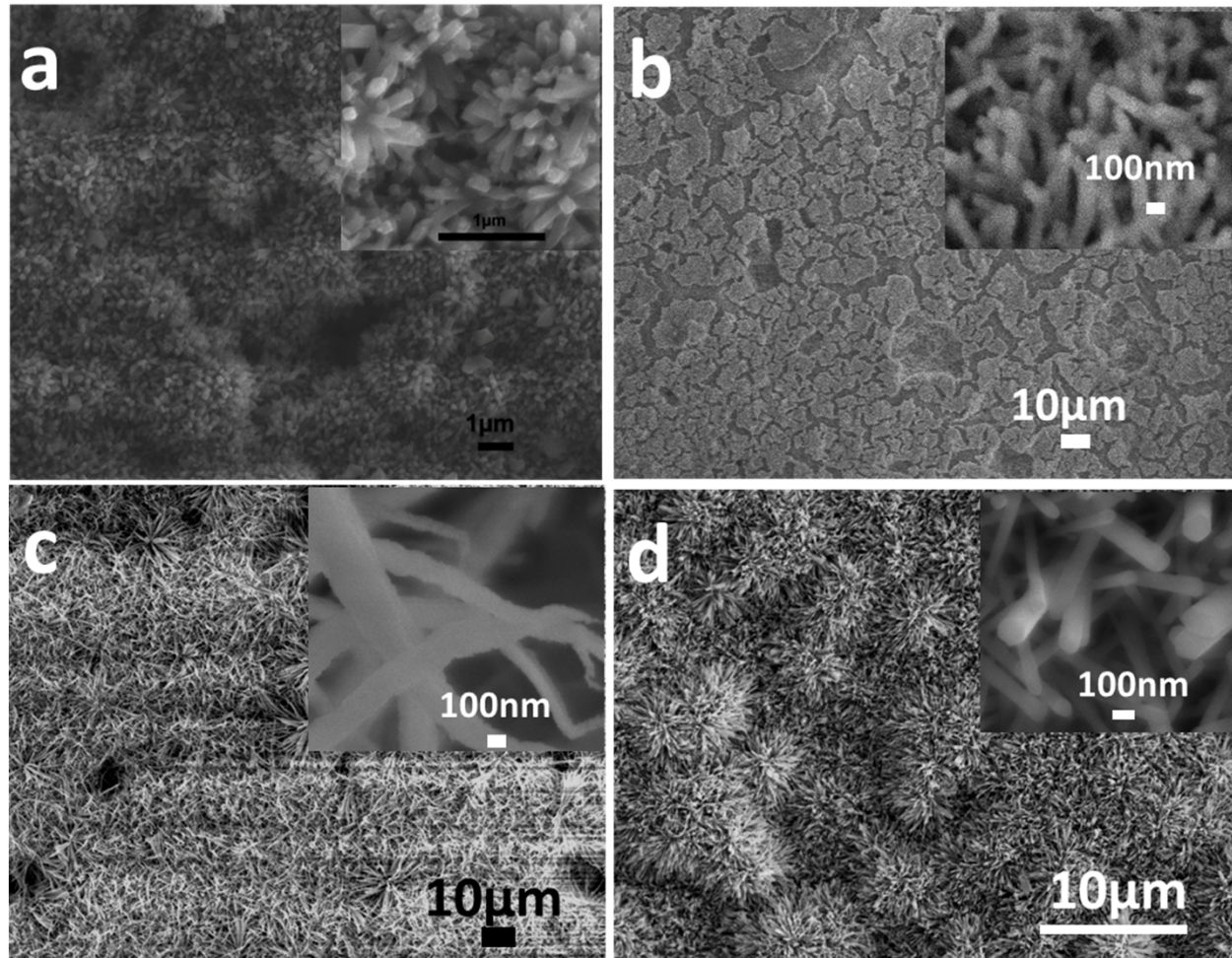
Gao, P.X. et al., US non-provisional patent filed, (2012).
Guo, Y.B.; Ren, Z.; Gao, P.X. et al., submitted, (2012).

Nano-array Catalysts



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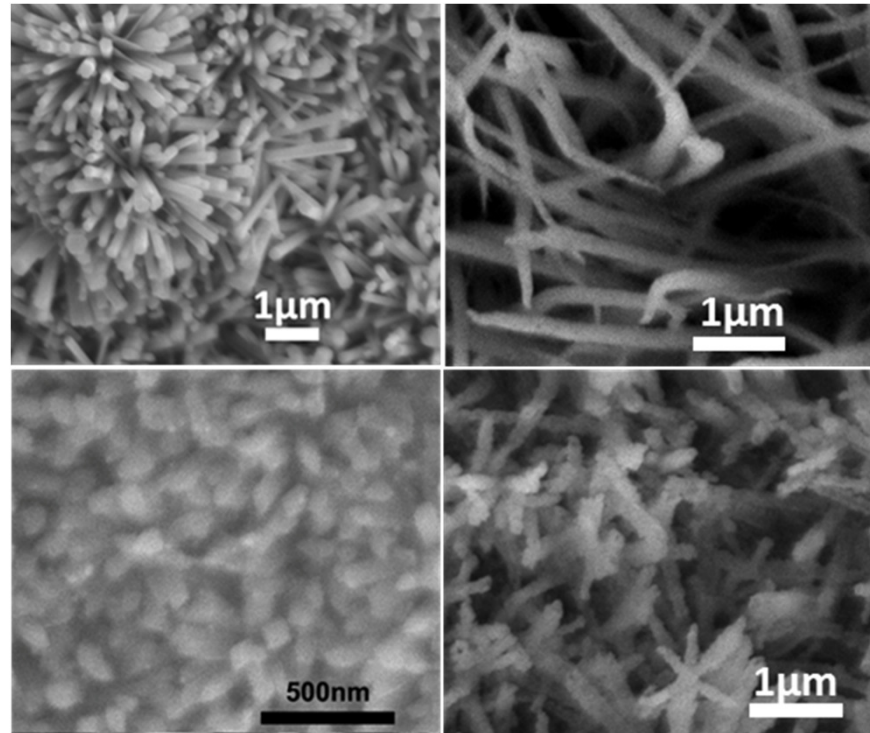
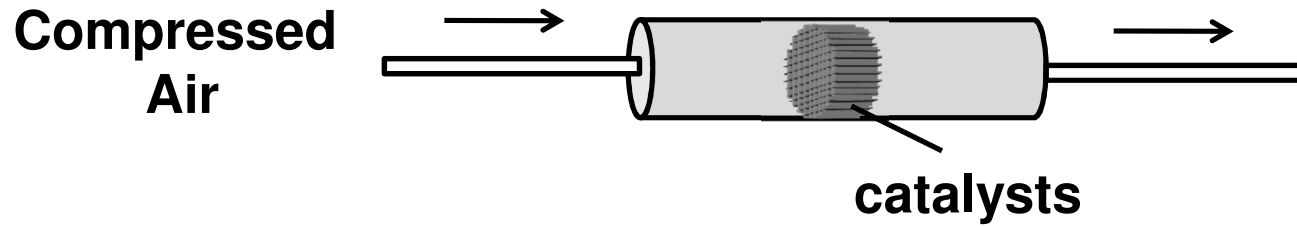
Thermal Stability



Morphology after thermal treatment

Gao, P.X. et al., US non-provisional patent filed, (2012).
Guo, Y.B.; Ren, Z.; Gao, P.X. et al., submitted, (2012).

Mechanical Stability



Gao, P.X. et al., US non-provisional patent filed, (2012).
Guo, Y.B.; Ren, Z.; Gao, P.X. et al., submitted, (2012).

Pt-loaded Nano-array Catalysts

To evaluate the performance of nano-array monolithic catalysts

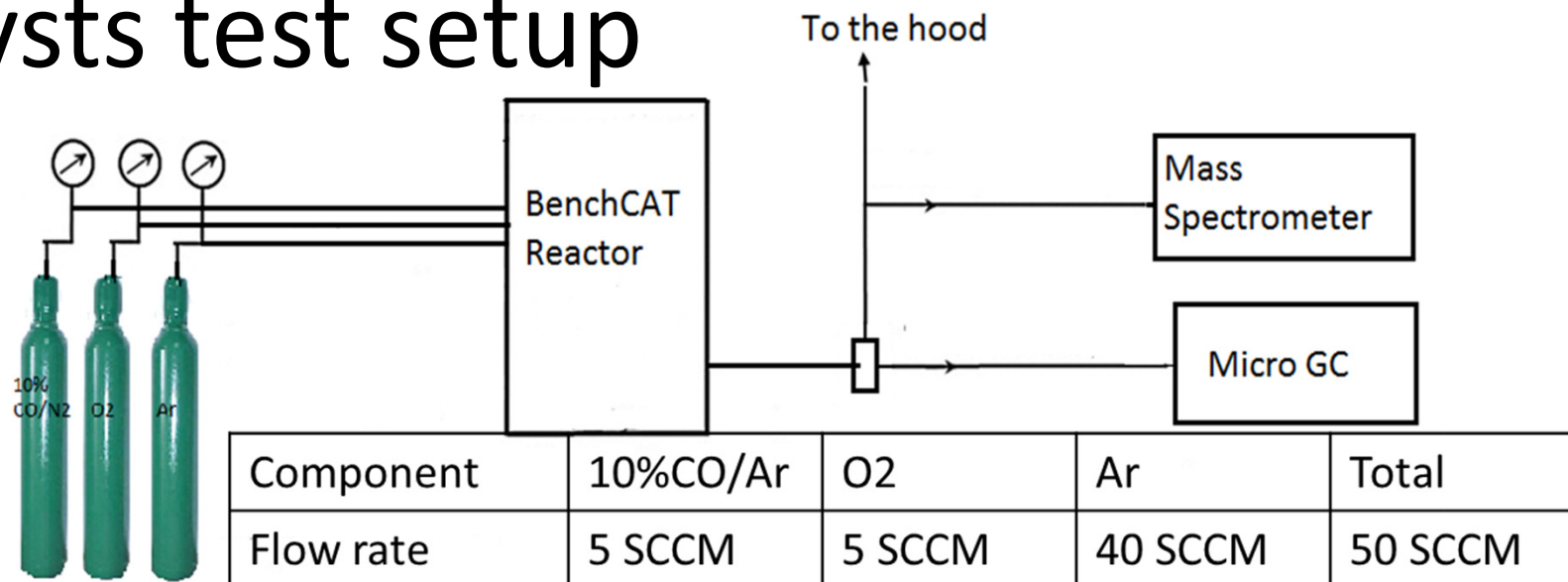
2nm Pt nanoparticles

Single crystalline

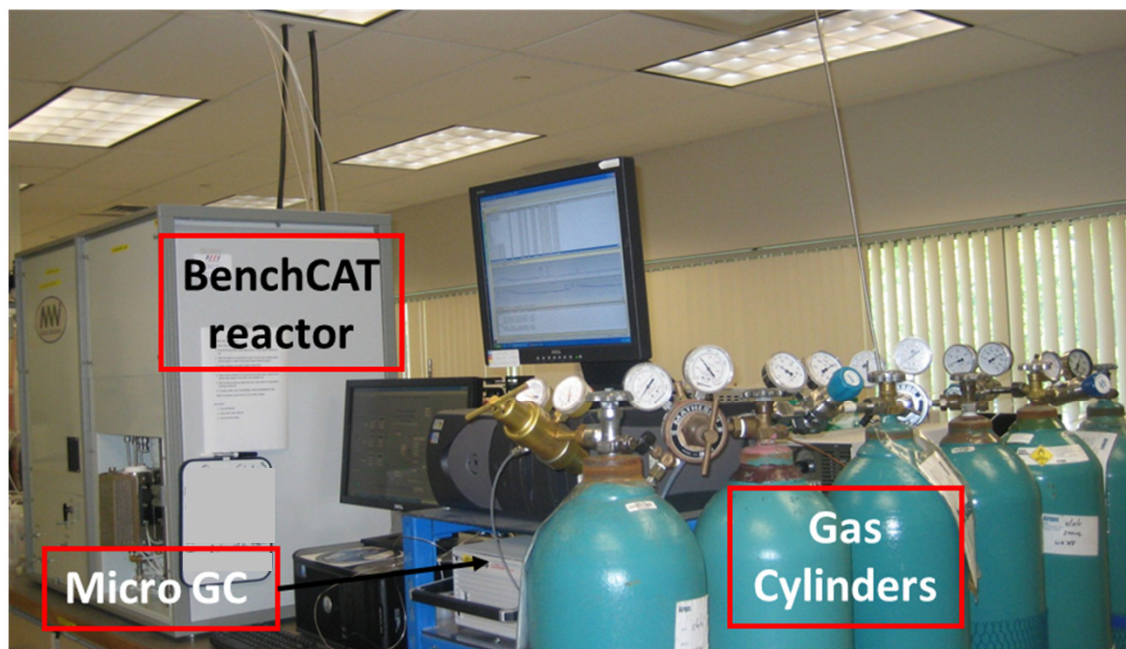
Good dispersion

Gao, P.X. et al., US non-provisional patent filed, (2012).
Guo, Y.B.; Ren, Z.; Gao, P.X. et al., submitted, (2012).

Catalysts test setup



Component	Concentration
CO	1%
O ₂	10%
Argon	balance
Space velocity	45, 454h ⁻¹
Temperature (°C)	20-500



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 Guo, Y.B.; Ren, Z.; Gao, P.X. et al., submitted, (2012).

Catalytic CO Oxidation

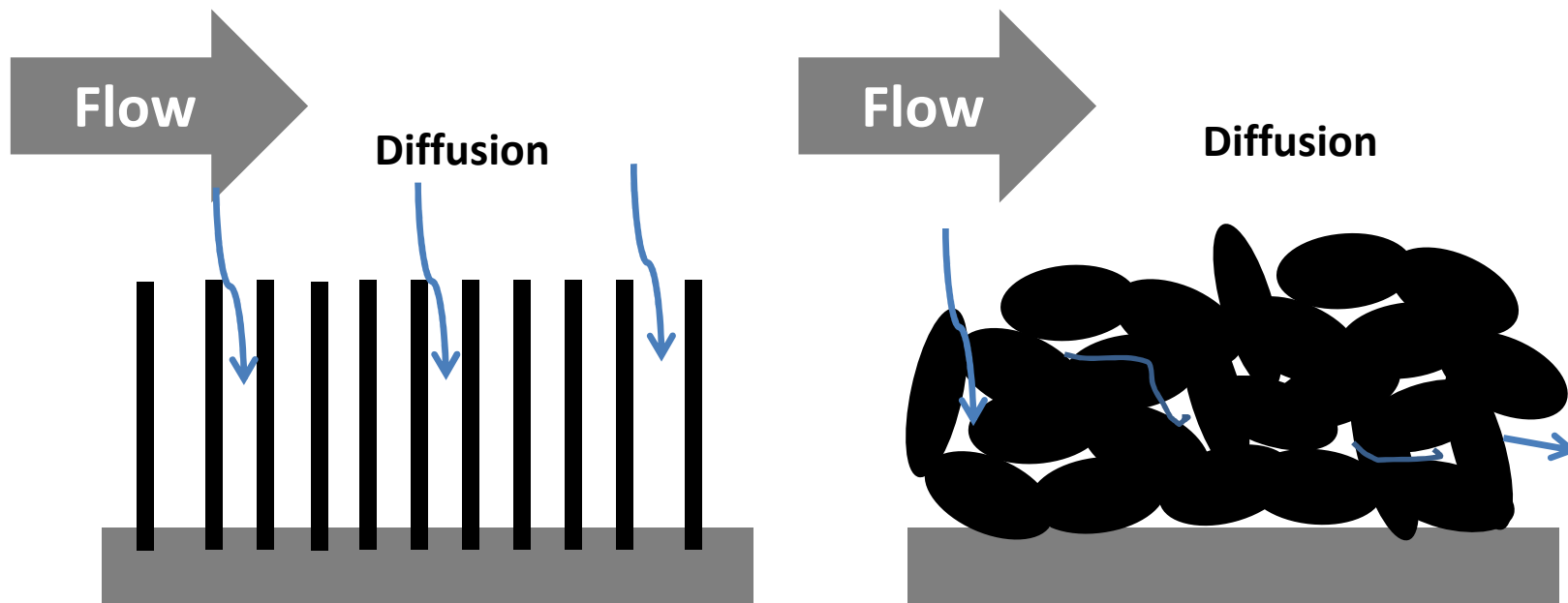
Light-off temperature=the temperature of 50% CO conversion

Light-off temperature: 180-260 °C

Conversion temperature: < 300 °C

Excellent catalytic stability in more than 20 hours.

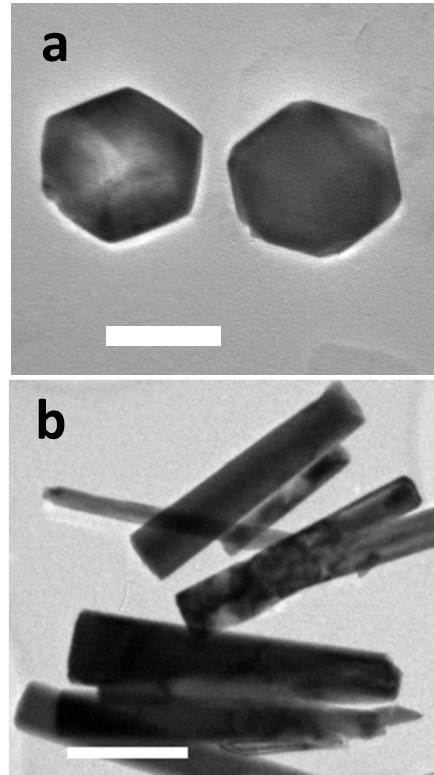
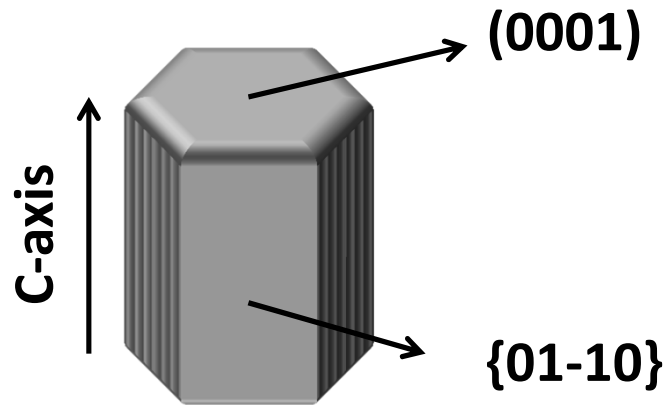
Catalysts	Precious metal (g/L)	Catalysts layer thickness(μm)	reference
Nano-array monolithic catalysts	0.5-1	1-10	This work
Washcoat monolithic catalysts (Al_2O_3 based)	2-12	15-100	Literature



CO Oxidation

Gao, P.X. et al., US non-provisional patent filed, (2012).
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Catalytic tunability



Scale bar: 200nm

Size, shape, and structure tunability

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Guo, Y.B.; Ren, Z.; Gao, P.X. et al., submitted, (2012).

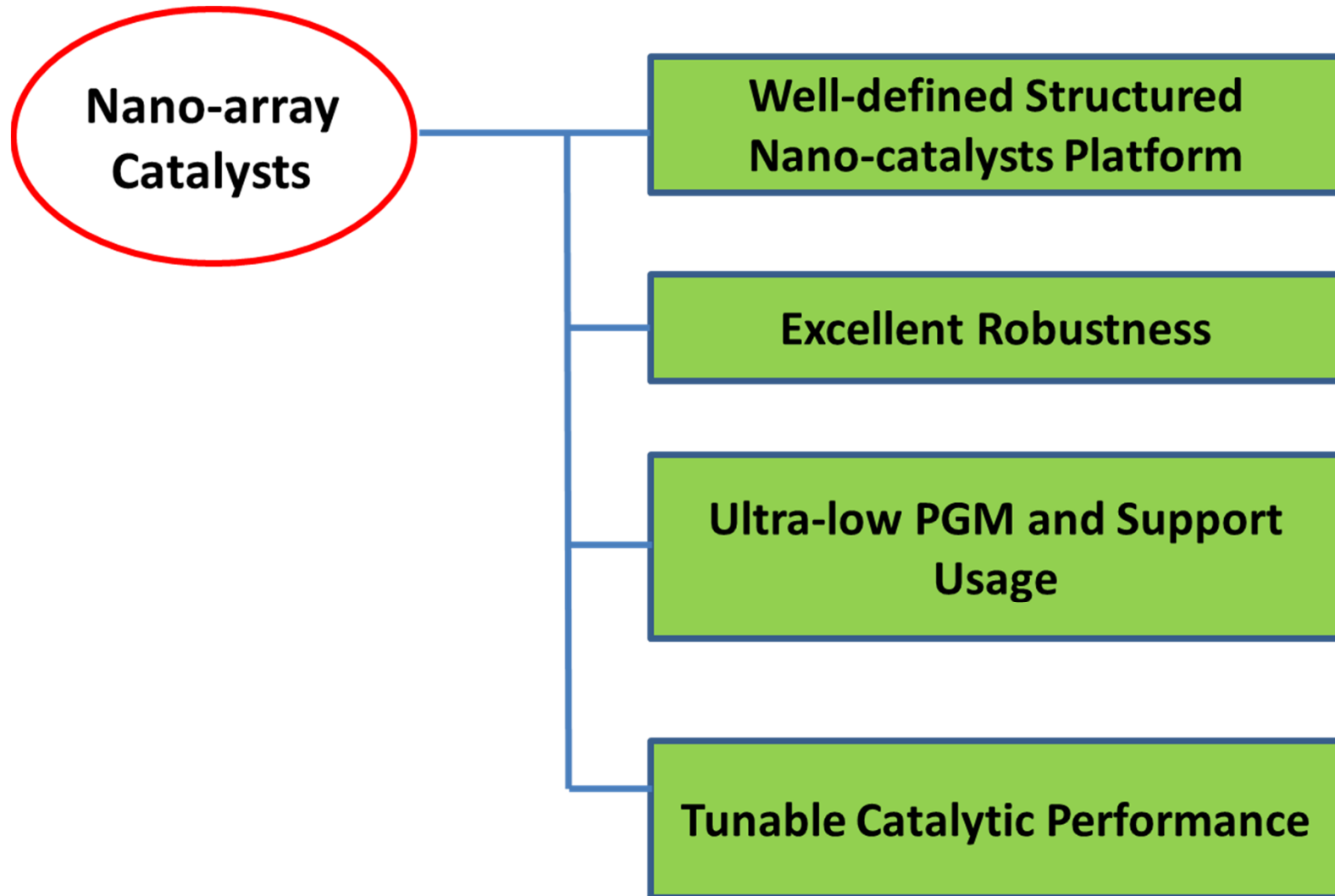
Catalytic CO Oxidation

Size tunable catalytic performance

7-time increase in catalytic activity in nano-array than powder form.

Shape and structure tunable light-off temperature

Conclusions



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