

Microwave-assisted Pechini Synthesis of Pd-Ni Nanocatalyst for Ethanol Electro-oxidation in Alkaline Medium

Mark Rohwer, Kenneth Ozoemena and Mmalewane Modibedi

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Introduction

Pechini method and
Microwave treatment
Catalytic activity
Characterisation
Conclusions

What is a fuel cell?

- A device that can convert chemical energy of a fuel directly to electricity
- Potentially very efficient and clean at source

Challenges:

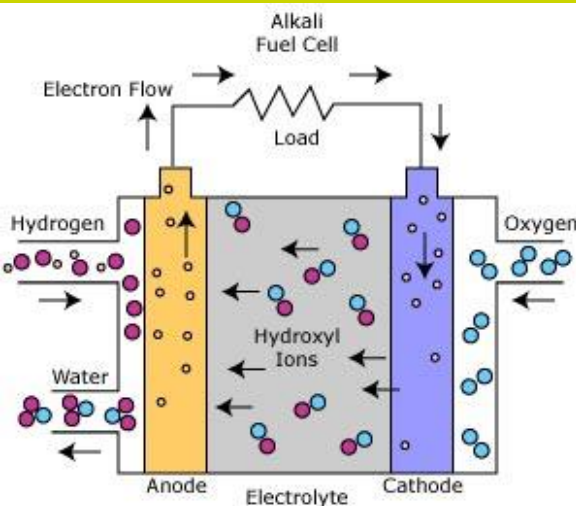
- Requirement for expensive PGM catalysts, usually dispersed on high-surface-area support, e.g. carbon black
- Efficiency, durability

Why alkaline, why ethanol?

- Improved O_2 reduction kinetics
- Non-PGM catalysts can be used (cost reduction)
- Ethanol is renewable and easily handled

Why Pd compounds?

- Effective catalyst for ethanol electro-oxidation



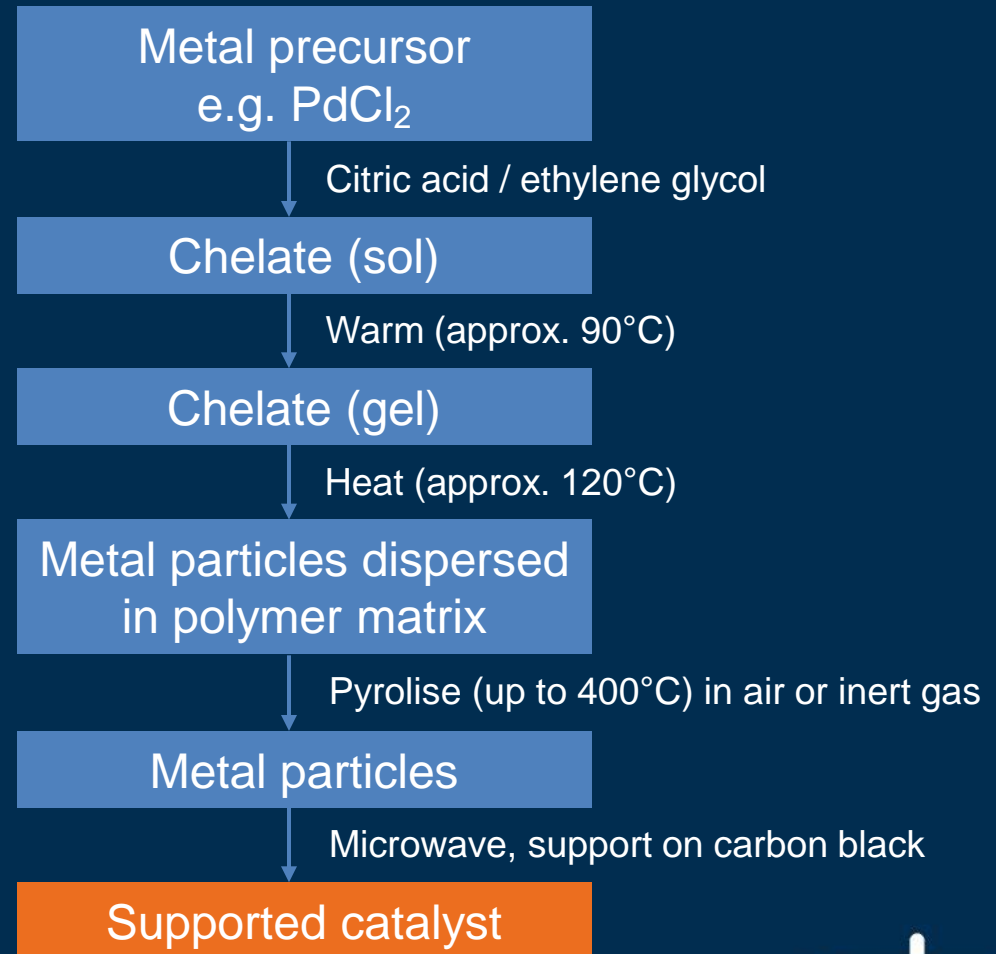
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P.M. Pechini, U.S. Patent
3 330 697 (1967).



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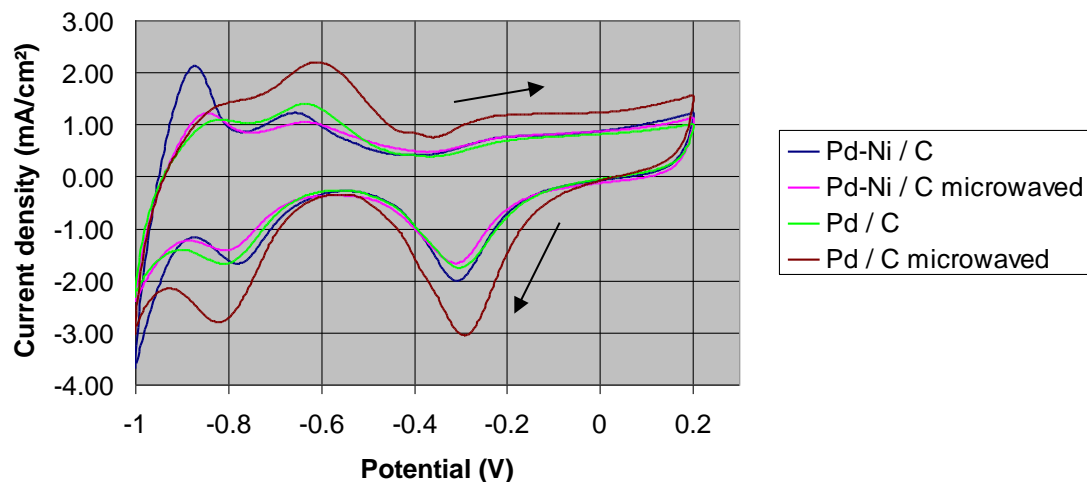
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Metal loading:
0.045 mg/cm²

Cyclic Voltammograms for EASA (1M KOH / N₂)



Electrochemically active surface area (m²/g)

Pd	35.7
Pd microwaved	66.5
Pd-Ni	35.0
Pd-Ni microwaved	28.6

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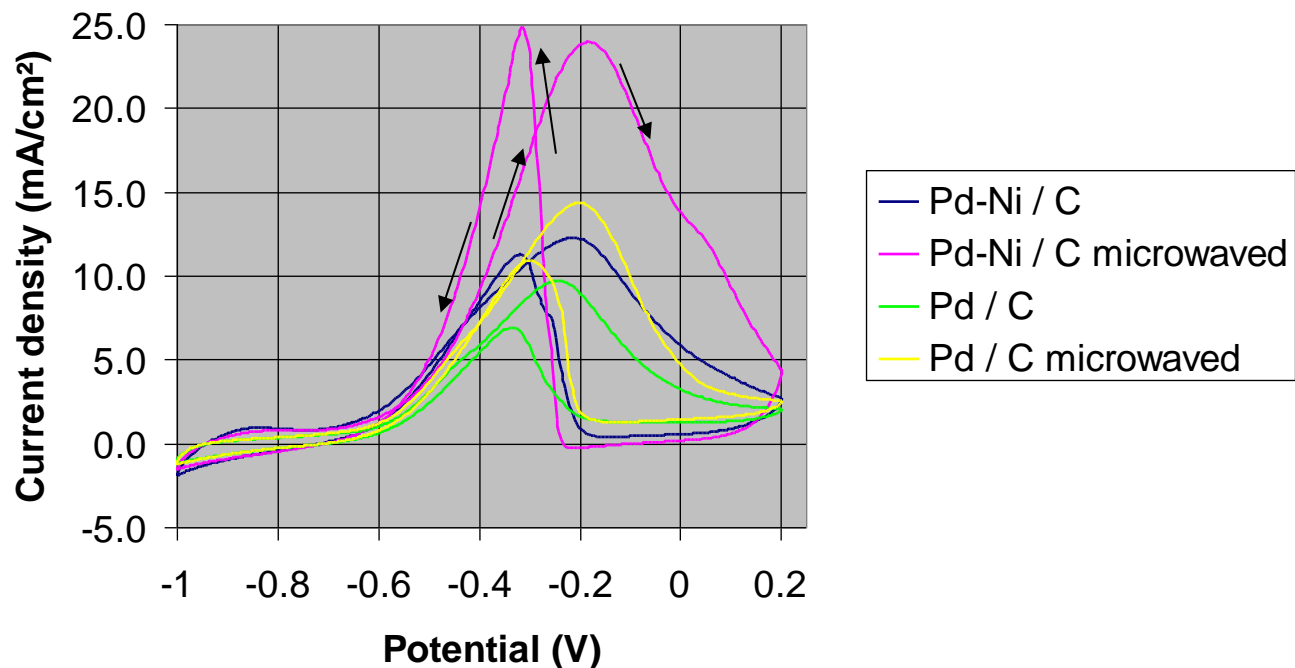
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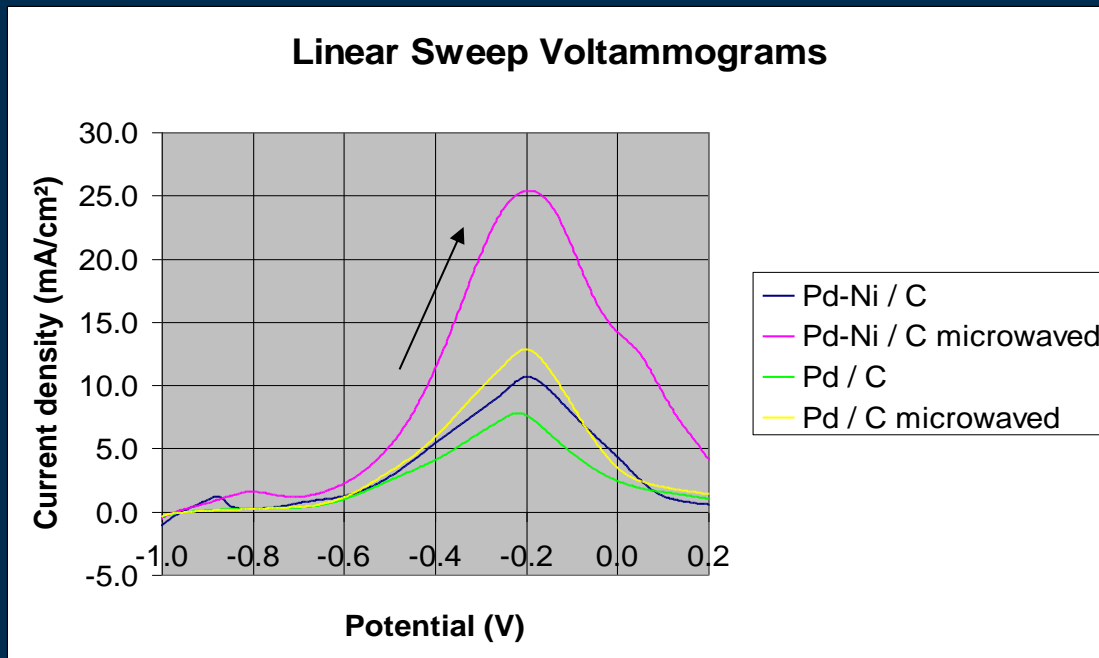
Cyclic Voltammograms (1M EtOH / 1M KOH)



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	Onset potential (mV)	Peak current density (mA/cm ²)
Pd	-750	7.80 (baseline)
Pd MW	-730	12.8 (+64%)
Pd-Ni	-765	10.6 (+36%)
Pd-Ni MW	-740	25.4 (+226%)

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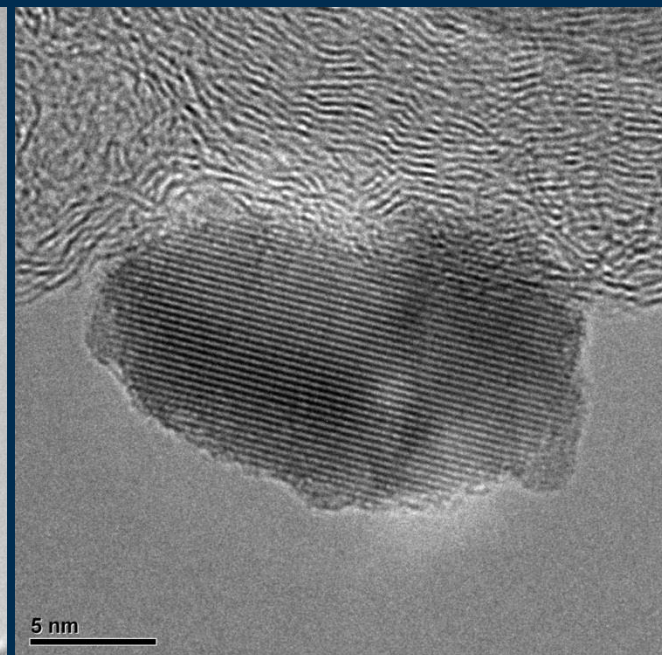
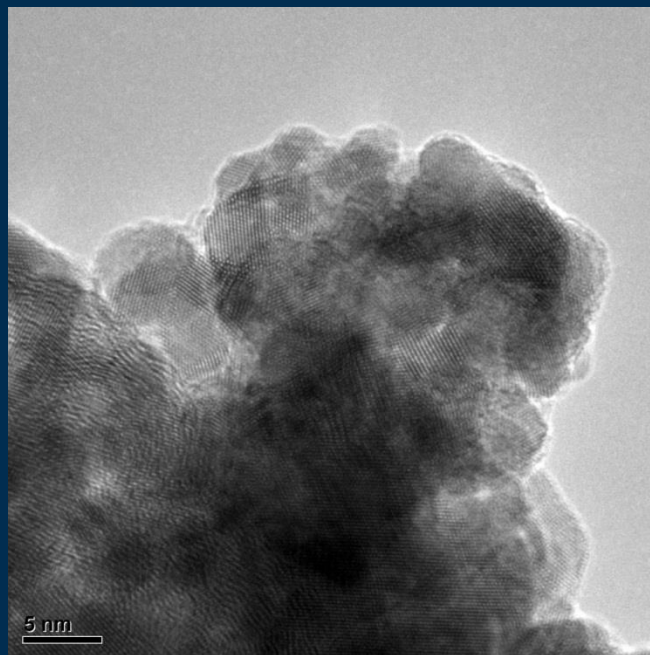
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High resolution TEM, Pd / C:

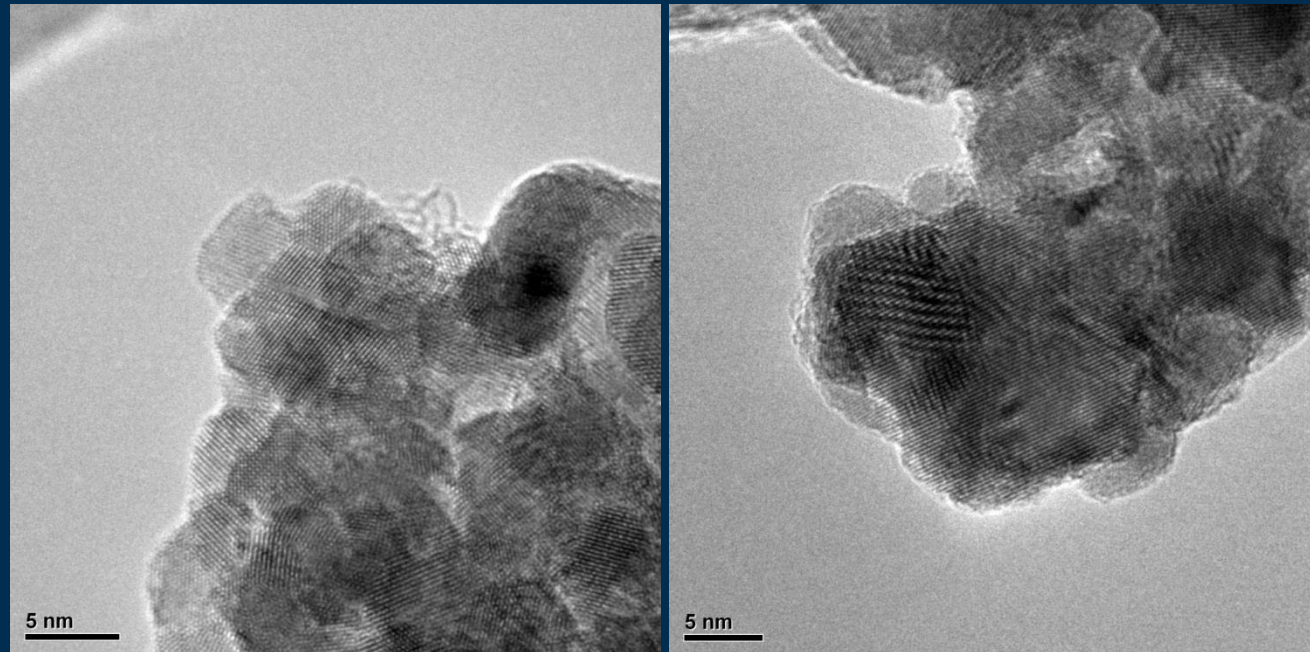


Particles vary from ca. 8 to ca. 15 nm and are often agglomerated

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High resolution TEM, Pd / C, microwaved:



Particles vary from ca. 8 to ca. 15 nm; somewhat more agglomeration observed than before microwaving

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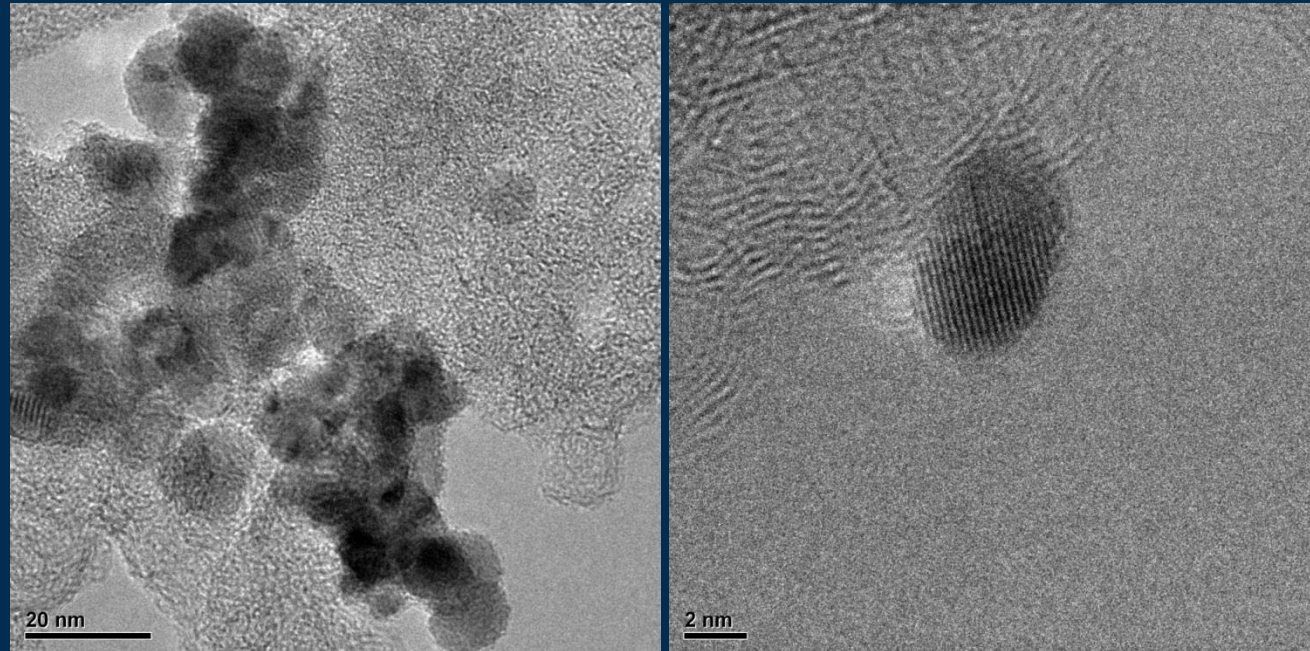
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High resolution TEM, Pd-Ni / C:

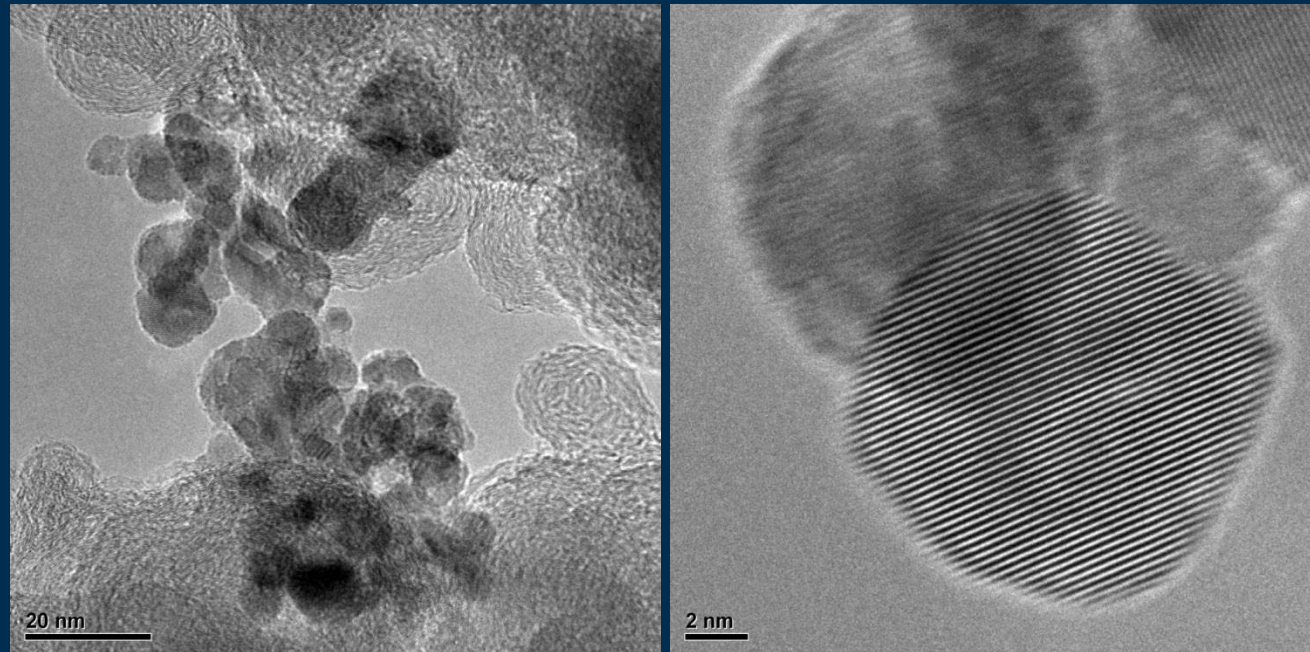


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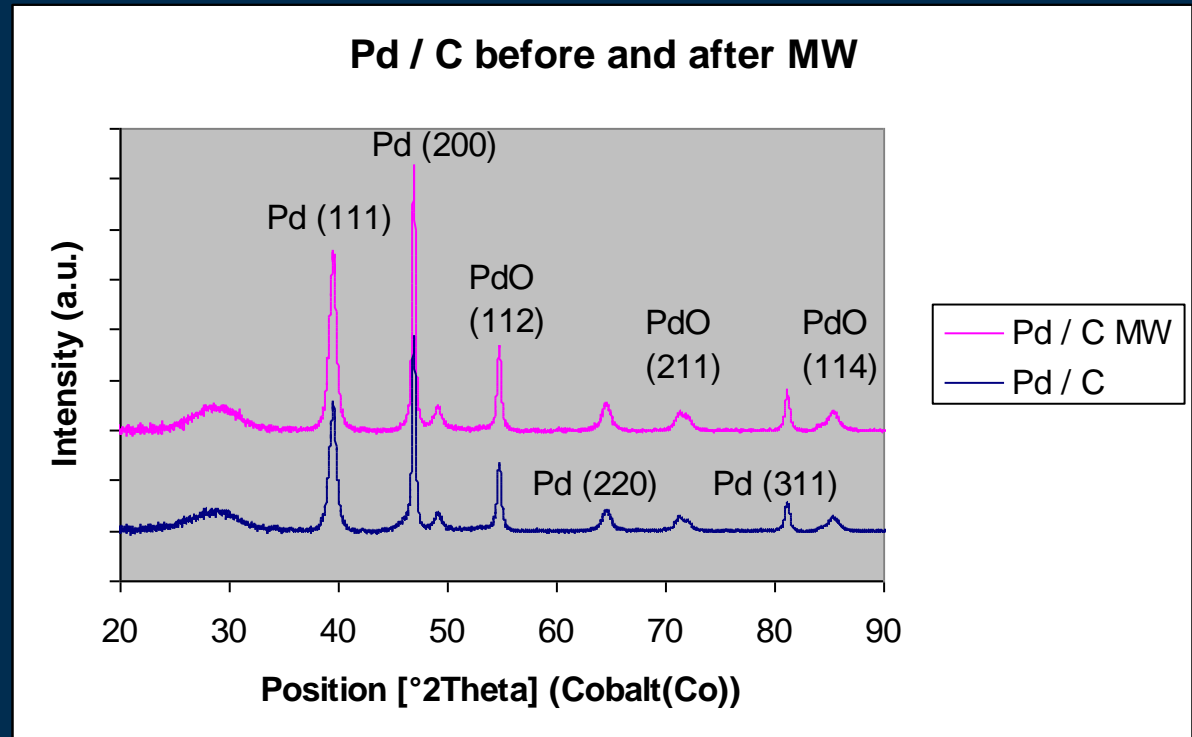


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X-ray diffraction spectroscopy:

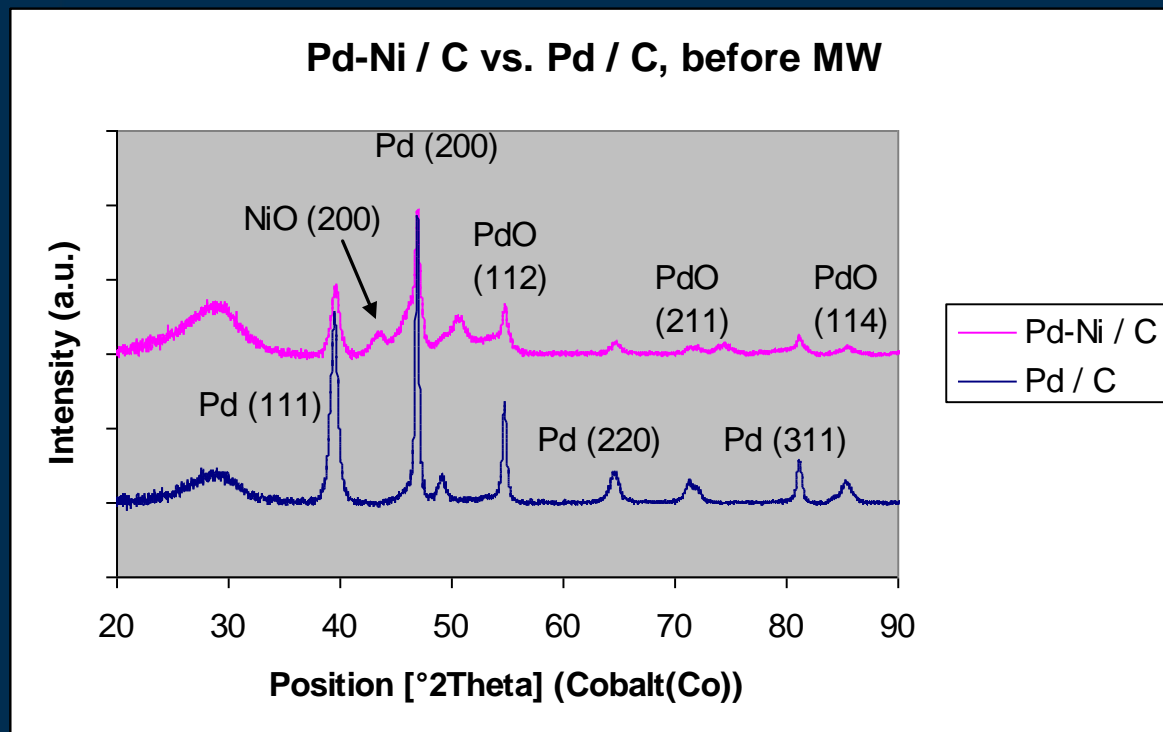


Lattice parameter: 3.90Å in both cases

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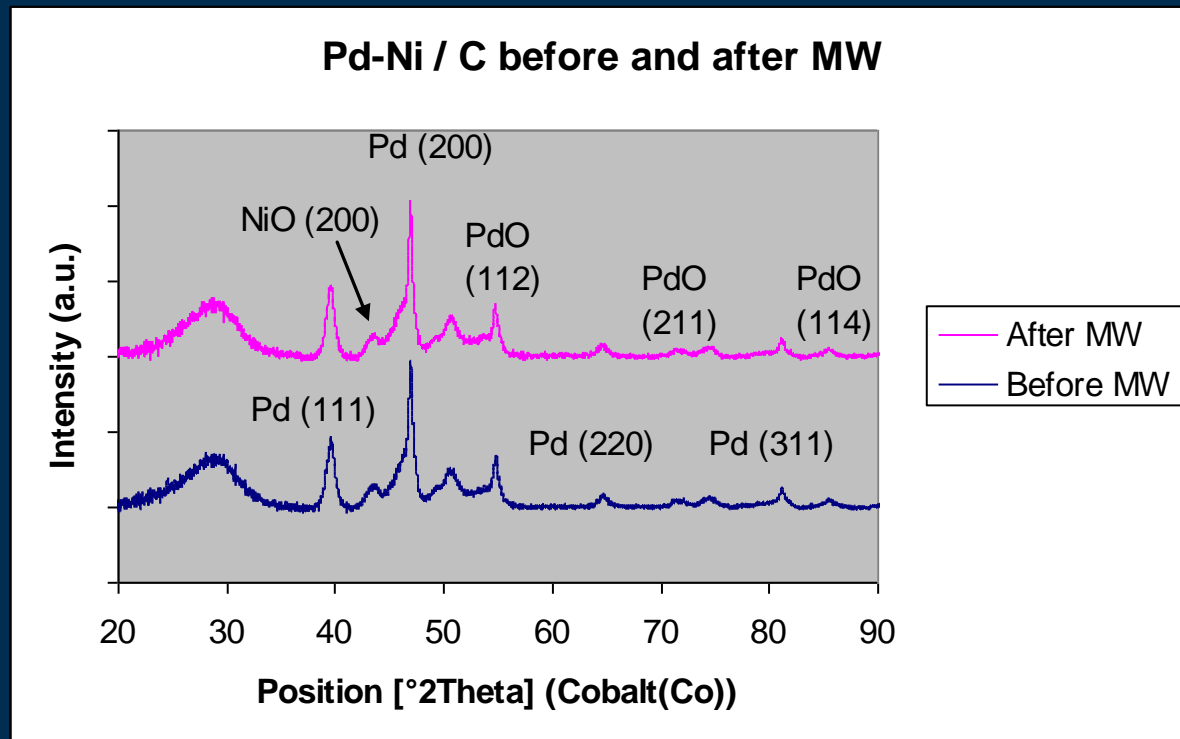


Pd-Ni vs. Pd	Pd (111)	Pd (200)	Pd (220)	Pd (311)
	+0.0887 $^{\circ}$	+0.1201 $^{\circ}$	-0.0169 $^{\circ}$	+0.0479 $^{\circ}$

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No previous records found of using Pechini method in conjunction with microwave treatment on Pd-Ni catalysts.

Addition of Ni to Pd enhanced current density (36%)

Microwaving enhanced certain aspects of catalytic activity

- Current density increased (Pd: 64%, Pd-Ni: 140%)
- Onset potentials were not influenced significantly
- EASA was only enhanced for Pd, not for Pd-Ni

Structural analysis showed no apparent differences after microwave treatment

- HR-TEM
- XRD

Hypothesis: possible surface modification, e.g. oxidation?
Investigation is ongoing.

Thank you!

Acknowledgements:

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