Synthesis, Activation and Electrochemical Study of PtRu Alloy Nanoparticles with Controlled Sizes and Compositions

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Background

- PtRu nanoparticles are highly active CO-tolerant anode catalysts for direct methanol fuel cells (DMFCs).
- The catalytic activity of particles is strongly dependent on the particle size, composition, size-distribution and dispersion.
- Capping agents-based colloidal synthetic approaches can provide good control over the particle size, shape, dispersion and size distribution.
- To catalytically activate the nanoparticles, low-temperature or non-thermal treatments need to be developed.

Synthetic procedures for PtRu nanoparticles

$Pt(acac)_2$ (80 mg) + $Ru(acac)_3$ (82 mg) + Diphenyl ether (20 ml)

↓ Heat to 110 °C (N_2 atmosphere)

↓ Inject oleylamine (1.36 ml)

↓ Inject 4 ml 1.0 M super hydride

↓ Reflux for 1 hr

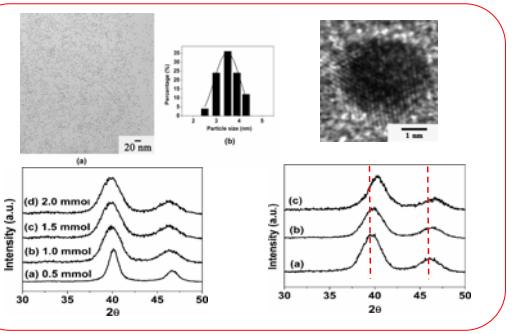
↓ Stop heating an cool down to 30 °C

↓ Wash with ethanol and disperse in Hexane

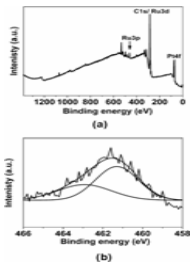
↓

Isolate particles by centrifugation

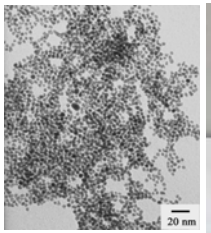
As-prepared FCC PtRu NPS with controlled sizes and compositions



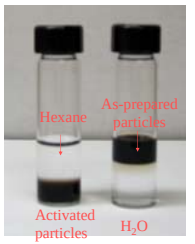
Transfer PtRu NPs from organic solvents to aqueous solutions

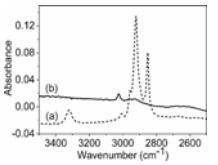


XPS spectra of particles



Particles dispersed in TMAOH aqueous solution

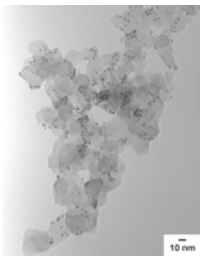




FT-IR spectra of particles:

(a) as-prepared (b) activated

Carbon-supported PtRu nanocatalysts



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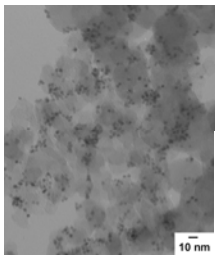

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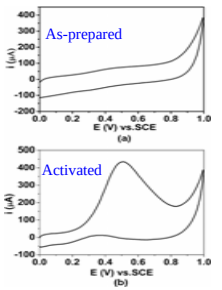
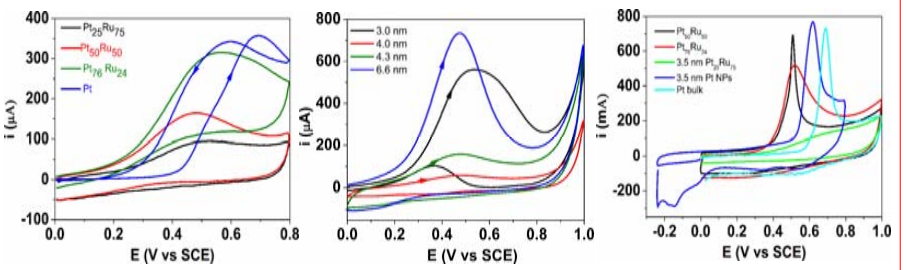


Activity for methanol oxidation

Size- and composition-dependent catalytic activity of PtRu particles for methanol and CO oxidation



Methanol oxidation

CO oxidation

Summary

- PtRu nanoparticles with controlled sizes and compositions were prepared by capping agent-based colloidal approach.
- PtRu nanoparticles can be catalytically activated without causing the sintering and oxidation of particles.
- The activated PtRu nanoparticles exhibit high catalytic activity for methanol and CO oxidation. Size- and composition study indicates the 3.5 nm $Pt_{50}Ru_{50}$ particles have the best activity

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