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One step synthesis of Pd/Pt nanoparticles for hydrogenation processes

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Abstract

An eco-friendly method has been developed for the synthesis of bimetallic palladium/platinum nanoparticles. The nanoparticles were synthesized using a bio-conjugate, chitosan-poly(3-hydroxybutyrate). The conjugate has both reducing and stabilizing properties owing to the presence of different functional groups in it, which also assists in enhancing the catalytic activity of bimetallic nanoparticles. The synthesized nanoparticle shows improved catalytic activity for hydrogenation process.

Synthesis of bimetallic nanoparticles

The synthesis was carried out by adding a certain amount of Chit-PHB (10 g/l) in a close vial containing both palladium and platinum precursors. The vial was heated at 130 °C for 30 minutes, the color of solution shifts from pale yellow to dark brown due to the bimetallic nanoparticles formation.

Results and discussion

SEM

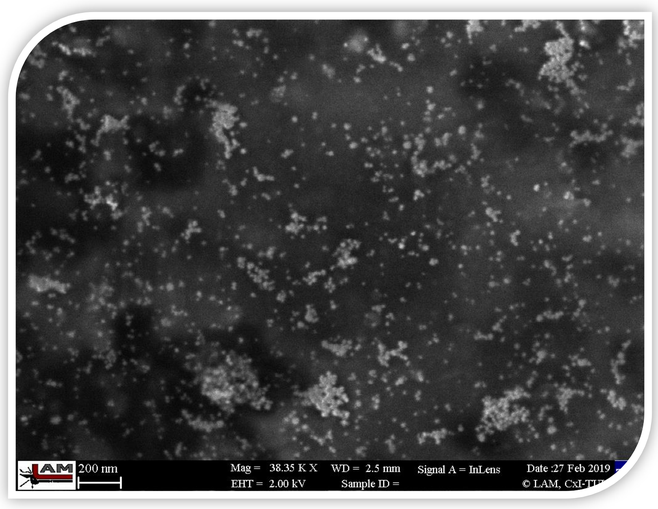

Figure 1 SEM picture of Pd/Pt synthesized by Chit-PHB

EDX

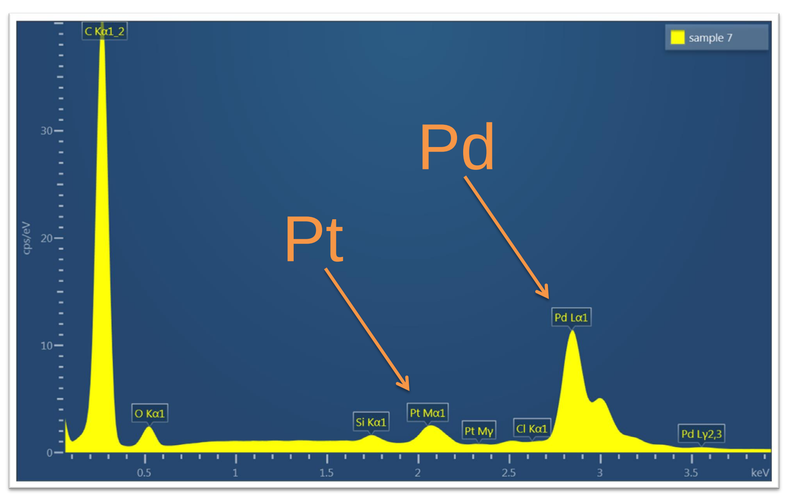

Figure 2 EDX analysis of Pd/Pt synthesized by Chit-PHB

Hydrogenation test

Temperature (°C)	Molar ratio (Pd:Pt)	k_{app} [min^{-1}]
150	1 : 1	0.186
140	1 : 1	0.352
130	1 : 1	1.825
130	1 : 0.5	1.197
130	0.5 : 1	0.958

Table 1 Catalytic hydrogenation of 4-nitrophenol in the system containing bimetallic Pd/Pt nanoparticles synthesized by different ratio of precursors with different temperatures. For determining the catalytic kinetics of nanoparticles pseudo-first-order kinetics was applied, the rate constant was calculated from the linear plot of ln(At/A0) versus time (min). The concentration of Chit-PHB used for all tests was 10 g/l.

Conclusion

The present work focuses on using a green approach to synthesize bimetallic Pd/Pt and their use for hydrogenation processes. Bimetallic nanoparticles were synthesized from potassium tetrachloropalladate(II) and platinum(II) chloride, the conjugate not only reduce both salts but also plays a key role in the stabilization of nanoparticles. The optimal synthesis conditions were found to be ratio 1 : 1 of salts precursor, 130 °C and Chit-PHB concentration of 10 g/l. These nanoparticles thus obtained were used for catalytic hydrogenation of nitrophenol.

Acknowledgment

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