Rhodium Nanoparticle Catalysts Stabilized with Modified Polyvinylpyrrolidones

**Significance:** Rhodium nanoparticle catalysts coated with a modified polyvinylpyrrolidone (PVP) were developed. The Rh nanoparticles (NPs) coated with 1 (1-Rh) exhibited thermal and catalytic stability compared to Rh NPs coated with PVP (PVP-Rh). Hydrogenation of aromatic substrates was performed with 1-Rh, or 2-Rh to give the corresponding cyclohexanes.

**Comment:** Rh NPs were characterized by X-ray photoelectron spectrometry (XPS), transmission electron microscopy (TEM), and high-resolution transmission electron microscopy (HRTEM). Catalyst 1-Rh was reused without loss of catalytic activity in the hydrogenation of phenol (14 times) and toluene (8 times) while PVP-Rh showed significant loss of catalytic activity.

**Preparation of rhodium nanoparticles (Rh NPs):**

1. **1-Rh** (1 x 10⁻³ mmol, stabilizer: Rh = 20:1) + H₂O (1 mL), H₂ (20 atm), 60 °C, 2 h

2. **2-Rh** (1 x 10⁻³ mmol, stabilizer: Rh = 20:1) + [bmim][BF₄] (1 mL), H₂ (20 atm), 60 °C, 2 h

**Diagram:**

- PVP: polyvinylpyrrolidone
- omim⁺: 1-methyl-3-octylimidazolium
- PVP-Rh, 1-Rh, 2-Rh
- 1-Rh (1 x 10⁻³ mmol, stabilizer: Rh = 20:1)
- 2-Rh (1 x 10⁻³ mmol, stabilizer: Rh = 20:1)

**Chemical Reactions:**

- Phenol (0.5 mmol) + H₂O (1 mL), H₂ (20 atm), 60 °C, 2 h
  - 99.8% yield
  - 0.1% yield

- Toluene + H₂ (20 atm), 60 °C, 2 h
  - 44.2% yield
  - 55.7% yield

- 99% yield
  - 69% yield

- 97% yield
  - 96% yield