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# **Pd@HNTs-CDNS-g-C3N4: A novel heterogeneous catalyst for promoting ligand and copper-free Sonogashira and Heck coupling reactions, benefits from halloysite and cyclodextrin chemistry and g-C3N4 contribution to suppress Pd leaching**

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## **Abstract**

For the first time, a ternary hybrid system composed of halloysite nanotubes, HNTs, cyclodextrin nanosponges, CDNS, and g-C3N4 is prepared and used for immobilization of Pd(0) nanoparticles and development of a heterogeneous catalyst, Pd@HNTs-CDNS-g-C3N4 for promoting ligand and copper-free Sonogashira and Heck coupling reactions in aqueous media. HNT as a porous tubular clay with outstanding thermal, mechanical and textural properties can act as a support for immobilizing Pd nanoparticles. The role of CDNS can be explained on the base of its capability to form inclusion complexes with substrates and bringing them in the vicinity of the catalytic active sites. Regarding the role of g-C3N4 in catalysis, it is proved that its presence can suppress the Pd leaching dramatically. The contribution of each component as well as synergistic effect between them results in high catalytic activity and recyclability (up to 10 reaction runs) of the catalyst.

**Keywords:** Halloysite nanoclay, Cyclodextrin nanosponges, g-C3N4, Pd(0) Nanoparticles, C-C coupling reaction