# Combining the elements palladium and ruthenium for industry

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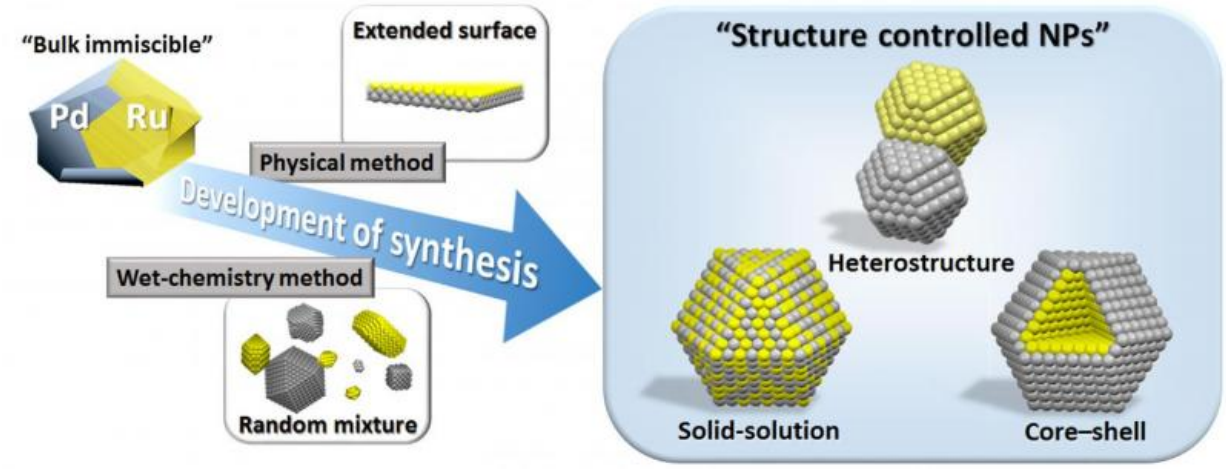


Synthesis of structure controlled bimetallic Pd-Ru nanoparticle alloys. Credit: Dongshuang Wu, Kohei Kusada, Hiroshi Kitagawa

The chemical elements palladium (Pd) and ruthenium (Ru) are both used separately in the chemical industry. For a long time, researchers have thought that combining the two could lead to improved and novel properties for industrial applications. However, the two elements do not readily mix together to become a single material.

A study published in the journal *Science and Technology of Advanced Materials* reviewed the latest research into the fabrication of Pd-Ru bimetallic nanomaterials.

Early research from the past two decades showed that simply combining Pd and Ru nanoparticles led to a mixture with better properties for industrial catalytic purposes than either of the two elements alone. Since then, many groups have reported on Pd-Ru alloy nanoparticles. By varying the fabrication methods and compositions of Pd and Ru, Pd-Ru nanomaterials with different properties arise that can be suitable in industrial applications.

In 2010, Hiroshi Kitagawa from Japan's Kyoto University and colleagues fabricated a "solid-solution alloy" (involving the addition of the atoms of one element to the crystalline lattice of the other in a high-temperature reaction) from two neighbour elements of Pd in the periodic table, silver (Ag) and rhodium (Rh). The resultant material had attractive properties for industrial purposes, including the ability to absorb hydrogen. Rh is important in a variety of reactions in the automotive industry as well as industrial exhaust gas treatment. But it is scarce and expensive. The success of Ag-Rh led the team to speculate that, due to their similarities, combining Pd and Ru into solid-solution alloy nanoparticles might lead to a material with similar properties, providing a potential alternative to Rh.

In 2014, the team was the first to synthesize Pd-Ru solid-solution alloy nanoparticles. They found the Pd-Ru nanoparticles had higher catalytic activities compared to Ru or Pd nanoparticles. More recently, they found these nanoparticles were highly active in a catalytic process important for purifying harmful gases from exhaust gas – even outperforming Rh nanoparticles.

Further research is needed to understand how varying the size of bimetallic material affects its physical and chemical properties. For example, research has found that growing less than five ultrathin Pd films on Ru causes the resultant material to be inert to oxygen even though Pd itself is highly reactive to it. Theoretical modelling will also

be important for predicting and explaining the properties of PdRu and other nanomaterials, the study concludes.

**More information:** Dongshuang Wu et al. Recent progress in the structure control of Pd–Ru bimetallic nanomaterials, *Science and Technology of Advanced Materials* (2016). DOI: 10.1080/14686996.2016.1221727

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