

## Applications

- Synthesis of new drugs
- Commercial-scale manufacturing of approved drugs
- Modification of natural substances
- Organic light-emitting diodes

## Advantages

- Simple and effective
- Uniform and rapid heating of reaction mixture
- Efficient production method
- High-activity of catalyst
- Stability of catalyst
- Recyclability of catalyst
- Environmentally friendly

## Inventors

[Frank Gupton, Ph.D.](#)

Mohammad El-Shall, Ph.D.

Ali Siamaki, Ph.D.

Abd El Rahman S. Khder

## Contact

T. Allen Morris, Ph.D., MBA

Associate Director

[amorris5@vcu.edu](mailto:amorris5@vcu.edu)

Direct 804-827-2211

## Market Need

Palladium-catalyzed cross-coupling reactions have become a cornerstone of modern organic synthesis and are used widely for pharmaceutical synthesis, modifying naturally-occurring substances and the formation of other complex organic molecules. These reactions are usually done under homogeneous conditions employing a ligand, however, there are several issues including the lack of catalyst-recyclability and potential contamination. Fixing palladium to a solid support such as carbon has solved some of these issues but often results in decreased catalyst activity. Therefore, the successful industrial application of these cross coupling reactions depends on the optimization of the catalyst systems.

## Technology Summary

Researchers at VCU have developed efficient methods for the production of ligand-free heterogeneous catalysts for Suzuki and Heck carbon-carbon cross coupling reactions using laser or microwave irradiation. More specifically, these methods generate highly active palladium nanoparticles supported on graphene. These catalysts offer a number of advantages over well known commercial catalysts such as high activity, stability of the catalyst, easy removal from the reaction mixture and recyclability without loss of activity. Moreover, the advantage of using the laser or microwave irradiation method over other conventional heating methods is that the reaction mixture is heated uniformly and rapidly, thereby allowing a simple and efficient method for production.

## Technology Status

U.S. Patent pending: 13/636,712

These methods have been demonstrated in the laboratory to produce highly active and stable catalysts.

This technology is available for licensing to industry for further development and commercialization.