



## Nano-Ceramic Coated Plastics

**Adding this non-stick coating to cookware can create easy-to-clean plastic containers.**

*John H. Glenn Research Center, Cleveland, Ohio*

Plastic products, due to their durability, safety, and low manufacturing cost, are now rapidly replacing cookware items traditionally made of glass and ceramics. Despite this trend, some still prefer relatively expensive and more fragile ceramic/glassware because plastics can deteriorate over time after exposure to foods, which can generate odors, bad appearance, and/or color change. Nano-ceramic coatings can eliminate these drawbacks while still retaining the advantages of the plastic, since the coating only alters the surface of the plastic. The surface coating adds functionality to the plastics such as self-cleaning and disinfectant capabilities that result from a photocatalytic effect of certain ceramic systems. These ceramic coatings can also provide non-stick surfaces and higher temperature capabilities for the base plastics without resorting to ceramic or glass materials.

Titanium dioxide (TiO<sub>2</sub>) and zinc oxide (ZnO) are the candidates for a nano-ceramic coating to deposit on the plastics or plastic films used in cook-

ware and kitchenware. Both are wide-bandgap semiconductors (3.0 to 3.2 eV for TiO<sub>2</sub> and 3.2 to 3.3 eV for ZnO), so they exhibit a photocatalytic property under ultraviolet (UV) light. This will lead to decomposition of organic compounds. Decomposed products can be easily washed off by water, so the use of detergents will be minimal. High-crystalline film with large surface area for the reaction is essential to guarantee good photocatalytic performance of these oxides. Low-temperature processing (<100 °C) is also a key to generating these ceramic coatings on the plastics.

One possible way of processing nano-ceramic coatings at low temperatures (< 90 °C) is to take advantage of *in-situ* precipitated nanoparticles and nanostructures grown from aqueous solution. These nanostructures can be tailored to ceramic film formation and the subsequent microstructure development. In addition, the process provides environment-friendly processing because of the aqueous solution. Low-temperature processing has also shown versatility to generate various nanostructures. The

growth of low-dimensional nanostructures (0-D, 1-D) provides a means of enhancing the crystallinity of the solution-prepared films that is of importance for photocatalytic performance.

This technology can generate durable, fully functional nano-ceramic coatings (TiO<sub>2</sub>, ZnO) on plastic materials (silicone, Teflon, PET, etc.) that can possess both photocatalytic oxide properties and flexible plastic properties. Processing cost is low and it does not require any expensive equipment investment. Processing can be scalable to current manufacturing infrastructure.

*This work was done by Junghyun Cho of Binghamton University for Glenn Research Center. Further information is contained in a TSP (see page 1).*

*Inquiries concerning rights for the commercial use of this invention should be addressed to NASA Glenn Research Center, Innovative Partnerships Office, Attn: Steven Fedor, Mail Stop 4-8, 21000 Brookpark Road, Cleveland, Ohio 44135. Refer to LEW-19005-1.*

## Preparation of a Bimetal Using Mechanical Alloying for Environmental or Industrial Use

**This technology could be of use for catalyst production or environmental applications.**

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Following the 1976 Toxic Substances Control Act ban on their manufacture, PCBs remain an environmental threat. PCBs are known to bio-accumulate and concentrate in fatty tissues. Further complications arise from the potential for contamination of commercial mixtures with other more toxic chlorinated compounds such as polychlorinated dibenzodioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs). Until recently, only one option was available for the treatment of PCB-contaminated materials: incineration. This may prove

to be more detrimental to the environment than the PCBs themselves due to the potential for formation of PCDDs.

Metals have been used for the past ten years for the remediation of halogenated solvents and other contaminants in the environment; however, zero-valent metals alone do not possess the activity required to dehalogenate PCBs. Palladium has been shown to act as an excellent catalyst for the dechlorination of PCBs with active metals. This invention is a method for the production of a palladium/magnesium

bimetal capable of dechlorinating PCBs using mechanical milling/mechanical alloying. Other base metals and catalysts may also be alloyed together (e.g., nickel or zinc) to create a similarly functioning catalyst system. Several bimetal catalyst systems currently can be used for processes such as hydrogen peroxide synthesis, oxidation of ethane, selective oxidation, hydrogenation, and production of syngas for further conversion to clean fuels. The processes for making these bimetal catalysts often involve vapor deposition.