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Scientists convert agricultural waste to high-value silicon carbide

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For U.S. Naval Research Laboratory scientists, the conversion of rice husks to high value SiC nanowires may provide new materials for electronic and structural applications. Credit: U.S. Naval Research Laboratory

Around the globe, billions of pounds of agricultural waste are generated every year. Scientists at the U.S. Naval Research Laboratory (NRL) are exploring ways to convert this waste into high-value silicon carbide that can be used for a variety of electronic and structural applications.

Agricultural waste products, such as rice husks, corn stalks, corncobs, sorghum leaves, wheat chaff, peanut shells, and other shells and residues are considered to have no value and are often plowed into the fields. They are sometimes disposed of by burning, which creates environmental hazards by the release of ash, CO_2, and nano-particles into the air.

Scientists are aware that these agricultural wastes have significantly high silica content in a molecular state, similar to hydrocarbons. Armed with that knowledge, NRL's Dr. Syed B. Qadri and his research team have discovered that these agricultural waste products can be economically transformed into silicon carbide (SiC) consisting of nanostructures and nanorods in various polytypes. The NRL team accomplished this by pyrolysis of the agricultural waste to produce the crystalline phases of silicon carbide, a highly stable compound, in various shapes of nanocrystals, nanorods, and nanowires. By selectively heating and cooling the agricultural waste products, they were able to systematically investigate the role of temperature rise and cooling rates. They observed that this heating and cooling process directly impacts the extended defect formation mechanisms that help in modifying the optical, electrical, and structural properties of these nanoparticles.

Because of its unique properties—high breakdown voltage, chemical inertness, high thermal conductivity, dimensional stability, wide band gap, high radiation resistance, and mechanical hardness—SiC is useful in many commercial electronic and structural devices. More recently, SiC nanoparticles have been demonstrated as a promising alternative to plasmonic metals in mid-infrared nanoscale optics, chemical sensing, and optical metamaterials. Dr. Qadri explains, "These SiC nanowires and nanotubes produced from agricultural waste products will have many industrial and potential nanotechnology applications."

The NRL research team is investigating the potential for use of SiC for chemical sensing, optical metamaterials, structural composites, and nanoscale electronic. Looking to the future, SiC nanoparticles also promise to provide dramatic enhancements in IR spectroscopy.

Provided by Naval Research Laboratory