Team develops eco-friendly, flame-retardant carbon plastic ideal for recycling

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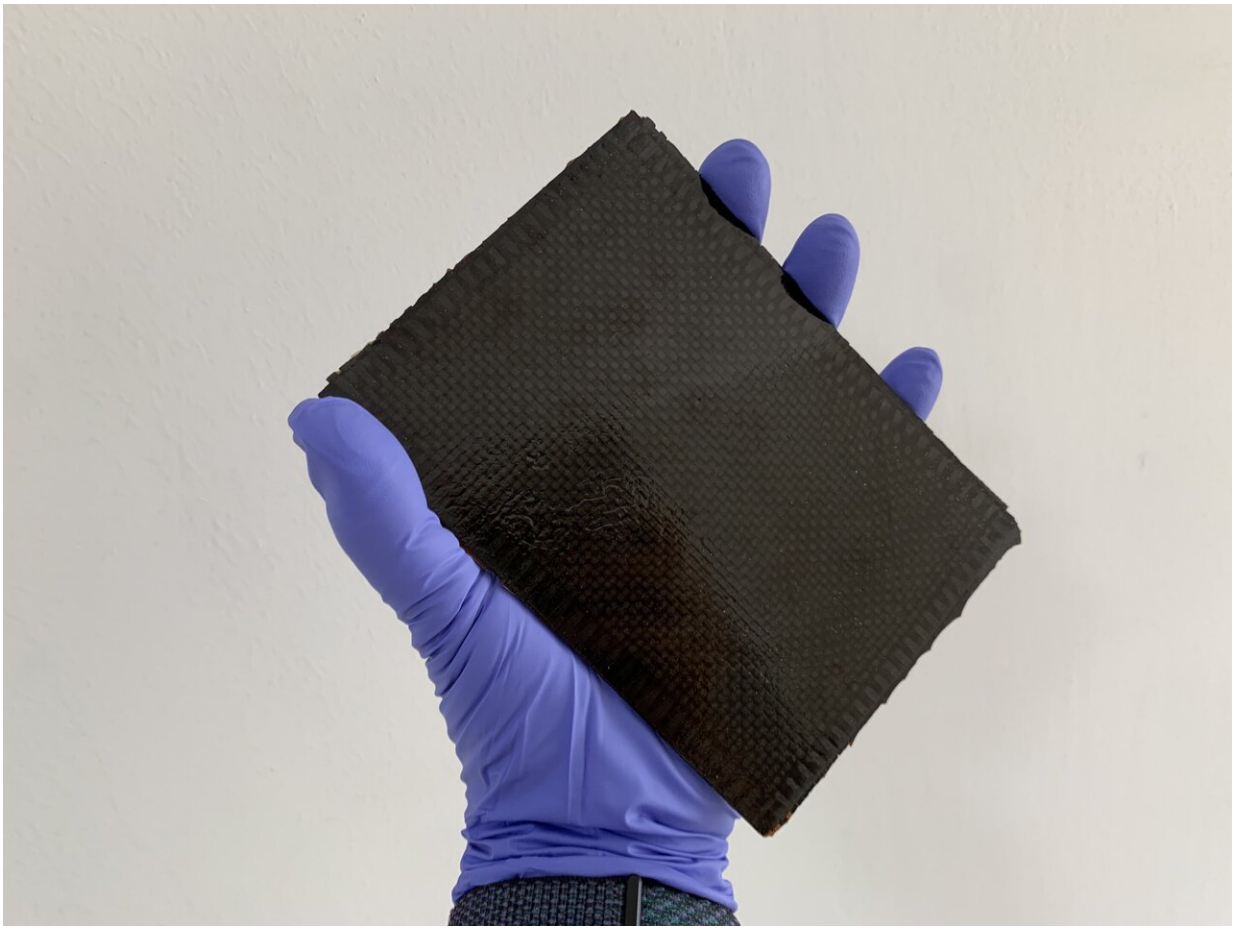

KIST research team used plant-originated tannic acid to develop a flame-retardant carbon fiber-reinforced plastic (CFRP) Credit: Korea Institute of Science and Technology

A flame-retardant carbon-fiber-reinforced composite material has been developed. Korea Institute of Science and Technology (KIST) announced that a research team from its Institute of Advanced Composite Materials, headed by Dr. Yong chae Jung used plant-originated tannic acid to develop a flame-retardant carbon fiber-reinforced plastic (CFRP), and also presented a method for its eco-friendly recycling.

CFRP, a composite material that contains carbon fiber, which is about four times lighter than steel yet 10 times stronger, is widely used in the aerospace, automotive, shipbuilding, and sports equipment industries. Structurally, CFRP is made up of carbon fiber and epoxy resin, which serve functions in this composite material similar to the respective roles that reinforcing rods and cement play in concrete structures. To achieve mechanical rigidity, the binding of carbon fiber and epoxy resin in CFRP must be strong. Moreover, CFRP must be fire-safe, as it is used for purposes closely related to everyday life, e.g., use as a construction material. To induce these traits in CFRP, sometimes it is synthesized with additives.

Due to its susceptibility to heat, CFRP had been made fire-safe by adding a halogen flame-retardant. However, the use of halogen in CFRP was banned worldwide, because it generates toxic substances when incinerated for recycling. As such, the task at hand was to make CFRP flame-retardant with the use of a non-toxic, safe material.


KIST
Korea Institute of
Science and Technology

A composite material of its eco-friendly recycling. Credit: Korea Institute of Science and Technology

Jung Yong-chae, head researcher at KIST's Institute of Advanced Composite Materials, sought to improve the mechanical rigidity and flame-retardance of CFRP with tannic acid, an eco-friendly substance. Tannic acid characteristically bonds strongly with carbon fiber. It also turns into charcoal when burned. Charred tannic acid functions as a barrier that blocks the inflow of external oxygen. By manufacturing epoxy resin from tannic acid and mixing it into carbon fiber, the KIST research team successfully developed a CFRP that is strong and flame-retardant.

Unlike conventional epoxy resin that is vulnerable to heat, epoxy resin made from tannic acid is flame-retardant and needs no additives. This means that the toxic substances generated when incinerating CFRP for recycling would no longer be a problem. Also, because conventional CFRP when burned decreased the performance of its epoxy resin, precluding complete recycling, the research team came up with a new recycling method.

By dissolving CFRP in water in a supercritical fluid state—i.e., temperature and pressure over a set level—over 99% of the CFRP could be recovered without reduced carbon fiber performance. It was also found that epoxy resin when dissolved produced a substance called "carbon dots," which can be used as an electronic material (Optronics, Sensing, Bioimaging etc.). Unlike the method of recycling by incineration, which burns up epoxy resin leaving only the incomplete carbon fiber to be recycled, this new method of recycling enables the recycling of all components of a composite material.

Head researcher Dr. Jung said, "We have created a composite material with an expanded range of application that is a dramatic improvement over conventional carbon fiber-reinforced plastic in terms of flame-retardancy, mechanical rigidity, and recyclability. These improved traits are significant in that they determine the range of application of said composite material." He added, "We will be reviewing the structure of this composite material to achieve even further improved properties and to further expand the range of its application."

More information: Young-O Kim et al, Recyclable, flame-retardant and smoke-suppressing tannic acid-based carbon-fiber-reinforced plastic, *Composites Part B: Engineering* (2020). DOI: 10.1016/j.compositesb.2020.108173

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