Transforming e-waste into a strong, protective coating for metal

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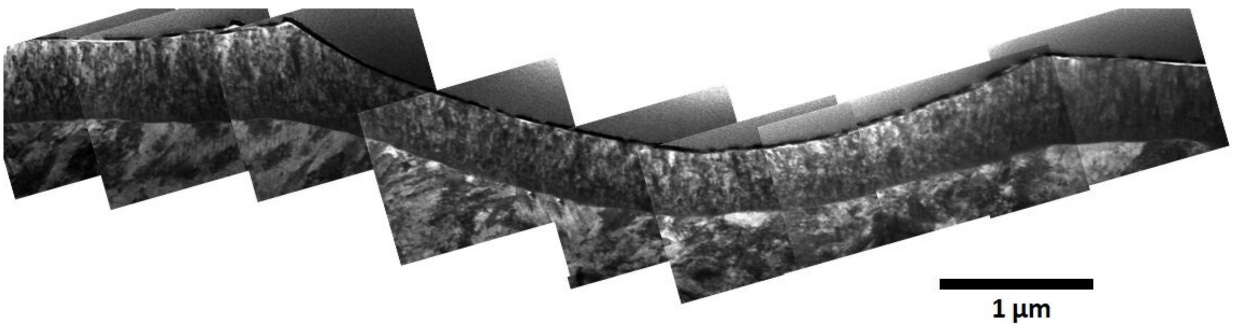

The material (thick gray line in the center of the image) derived from e-waste remained intact when indented, and increased the hardness of the steel below it. Credit: Adapted from *ACS Omega* 2020, DOI: 10.1021/acsomega.0c00485

A typical recycling process converts large quantities of items made of a single material into more of the same. However, this approach isn't feasible for old electronic devices, or 'e-waste,' because they contain small amounts of many different materials that cannot be readily separated. Now, in *ACS Omega*, researchers report a selective, small-scale microrecycling strategy, which they use to convert old printed circuit boards and monitor components into a new type of strong metal coating.

In spite of the difficulty, there's plenty of reason to recycle e-waste: It contains many potentially valuable substances that can be used to modify the performance of other materials or to manufacture new, valuable materials. Previous research has shown that carefully calibrated high temperature-based processing can selectively break and reform chemical bonds in waste to form new, environmentally friendly materials. In this way, researchers have already turned a mix of glass and plastic into valuable, silica-containing ceramics. They've also used this process to recover copper, which is widely used in electronics and elsewhere, from circuit boards. Based on the properties of copper and silica compounds, Veena Sahajwalla and Rumana Hossain suspected that, after extracting them from e-waste, they could combine them to create a durable new hybrid material ideal for protecting metal surfaces.

To do so, the researchers first heated glass and plastic powder from old computer monitors to 2,732 °F, generating silicon carbide nanowires. They then combined the nanowires with ground-up circuit boards, put the mix on a steel substrate then heated it up again. This time the thermal transformation temperature selected was 1,832 °F, melting the copper to form a silicon-carbide enriched hybrid layer atop the steel. Microscope images revealed that, when struck with a nanoscale indenter, the hybrid layer remained firmly affixed to the steel, without cracking or chipping. It also increased the steel's hardness by 125%. The team refers to this targeted, selective microrecycling process as "material microsurgery," and say that it has the potential to transform e-waste into advanced new surface coatings without the use of expensive raw materials.

More information: Rumana Hossain et al. Material Microsurgery: Selective Synthesis of Materials via High-Temperature Chemistry for Microrecycling of Electronic Waste, *ACS Omega* (2020). DOI: 10.1021/acsomega.0c00485

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