# Researchers share their protocol for handling carbon nanotubes

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In collaboration with a Rice University laboratory, the Energy Safety Research Institute (ESRI) at Swansea University has developed and shared a low-cost method to safely handle the transfer of bulk carbon nanotubes and other nanomaterials. It doesn't take much more than 10 minutes, a couple of bags and a big bucket to keep the nanomaterials in their place.

The Director of the Energy Safety Research Institute (ESRI) at Swansea University Professor Andrew R. Barron works with bulk carbon nanotubes on a variety of projects. Years ago, members of his research team at Rice University in Houston, Texas, became concerned that nanotubes could escape into the air, and developed a cheap and clean method to keep them contained as they were transferred from large containers into jars for experimental use.

More recently Professor Barron himself became concerned that unlike the BREEAM Outstanding laboratories of ESRI, too few labs around the world were employing best practices to handle nanomaterials, so decided to share what his team had learned.

Professor Barron said: "There were a series of studies that said if you're going to handle nanotubes, you really need to use safety protocols. Then I saw a study that said many labs didn't use any form of hood or containment system. In the U.S., it was bad, and in Asia it was worse even though there were a significant number of labs scaling up to use these materials at the kilogram scale without taking the proper

precautions."

The lab's inexpensive method is detailed in an open-access paper in the Springer Nature journal *SN Applied Sciences*.

In bulk form, carbon nanotubes are fluffy and disperse easily if disturbed. The Barron research labs typically store the tubes in 5-gallon plastic buckets, and simply opening the lid is enough to send them flying owing to their low density.

Varun Shenoy Gangoli, a research scientist in Barron's lab in the Department of Chemistry, at Rice University, and Pavan Raja, a scientist with Rice's Nanotechnology-Enabled Water Treatment centre, developed their own method that involves protecting the worker and sequestering loose tubes when removing smaller amounts of the material for use in experiments.

Full details are available in the paper, but the precautions include making sure workers are properly attired and wearing lab coats, full goggles and face masks, along with two pairs of gloves duct-taped to the lab coat sleeves. The improvised glove bag involves a 25-gallon rubbish bin with a plastic bag taped to the rim. The unopened storage container is placed inside, and then the bin is covered with another transparent trash bag, with small holes cut in the top for access.

After transferring the nanotubes, acetone wipes are used to clean the gloves and more acetone is sprayed inside the barrel so settling nanotubes would stick to the surfaces. These can be recovered and returned to the storage container.

Professor Barron said: "It took lab members time to learn to use the protocol efficiently, but now they can get their samples in 5 to 10 minutes. I'm sure other labs can and will enhance the technique for their

own circumstances."

A poster presented at the 9th Guadalupe Workshop on Carbon Nanotubes on this matter earned recognition and discussion among the world's premier researchers in the field, noting the importance of the work for agencies in general.

Professor Barron said: "I think this is something people will use, as it's a practical guide that helps everybody from high schools and colleges that are starting to use nanoparticles for experiments to small companies. That was the goal: Let's provide a process that doesn't cost thousands of dollars to install and allows you to transfer nanomaterials safely and on a large scale. By publishing the guide in an open-access journal it helped to maximise the reach and impact across the globe."

**More information:** Varun Shenoy Gangoli et al. The safe handling of bulk low-density nanomaterials, *SN Applied Sciences* (2019). DOI: 10.1007/s42452-019-0647-5

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