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Nano-Metallic Gluing

In our industrial world, soldering or welding are usually the chosen methods to join metal parts together. It is hard to imagine a large manufacturing facility using glue to join the metal parts that go into the thousands of products that come off their assembly line each week.

How things are joined in some manufacturing facilities could change if a new metal bonding technology, nano-metallic gluing, proves itself to be better than current procedures. The process has recently been developed as a joint project at Boston's Northeastern University and the University of North Florida, Jacksonville. The January 2016 issue of the *Advanced Materials & Processes* journal published the research on this new process and I think you will find this technology fascinating.

When welding or soldering is used to join metals, a great deal of heat must be applied to the location of the joint. When joining metals today it is often critical to keep the heat needed for soldering or welding away from parts of the assembly that can easily be damaged by heat. The continual shrinking of electronic components has made it much more difficult to heat up extremely small areas without having the heat spill over into adjacent areas that will fail if they are overheated.

For these reasons, a cold bonding process that could be as fast as soldering, is easy to apply, is able to dissipate heat and withstand high temperatures, and also conduct electricity could be a boom to the manufacturing of next generation electronics. Besides all of the above listed attributes, the nano-metallic gluing process requires very little pressure to join the two parts that are being bonded together to form the permanent joint.

To further add to its favorable characteristics, this metal glue can also be used to join metal tubes and vessels that will carry loads under pressure. See Photo 1. It also appears that it could be used in many different manufacturing scenarios including bonding metals to glass.

This joining process is called nano-metallic gluing rather than soldering because it is applied without heat. To join two surfaces together, one surface is coated with a microscopic metallic layer of a nanorod material that has fine hairs that stand up like the bristles on a hair brush. See Fig. 1. These bristles are coated with the element indium. The surface to be joined is also coated with the same metallic nanorod material, but the standing up bristles on its surface are coated with the element gallium.

At this point each surface has what can best be described as a

Images courtesy MesoGlue

Photo 1—Nano-metallic gluing can attach electronic components without heat, produce a joint that is strong enough to carry loads under pressure, and attach metals to other materials. Its completed joints can conduct electricity.

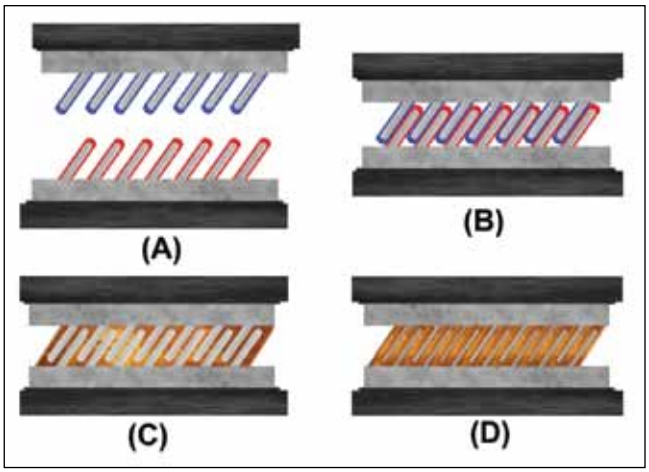

Fig. 1—(A) The nanorods are coated onto the parts to be joined. (B) The parts are pressed together. (C) A chemical reaction takes place and the glue turns into a liquid. (D) The glue turns into a solid metallic alloy.

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microscopic layer of hairs or bristles standing up from the surface to be glued like microscopic unattached pieces of Velcro. When the bristles of these two metals are pressed together, their microscopic hair fibers get entwined together, causing a chemical reaction.

This reaction not only causes them to join together, but also causes them to form a very strong bond to the surface of the metal or other material that they coat. Physically they go from a solid to a liquid that then hardens into a solid again. The two materials are permanently joined and the joint can conduct electricity, which would be extremely important if the joint is part of an electronic circuit.

Even though these joints are formed cold they can equal the strength of a joint that was made by welding, brazing, or soldering. To further the development of this technology Professor Huang, the project director from Northeastern University, and two of his former PhD students have formed the company MesoGlue to expand this process to multiple commercial and home hobby uses.

To further your understanding of nano-metallic gluing, watch the YouTube video below. If you want a PhD level description of this process, you can read the full *Advanced Materials & Processes* journal article at: http://mio.asminternational.org/amp/201601/files/assets/basic-html/page-22.html#.

Taking It a Step Further

Go to the hardware section of your favorite hobby or home improvement store. You will see shelves full of different types of glues.

1. Examine the product labels. How are these glues chemically different?

2. Set up experiments to see which type of glue is most effective for attaching different types of materials. td