

# Manufacturing News

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# Unravelling the Mysteries Behind Friction Stir Welding

Wire electrical discharge machines (EDMs) are most often associated with precision tool and die machining, but it is important to note that this crucial manufacturing technology has numerous other applications besides trim dies, blanking punches and jig boring quality hole finishing. At the University of North Texas (UNT) in Denton, for example, researchers are using wire EDM to support their investigations into the metallurgical properties of several relatively novel machining and fabricating processes, 3D printing among them.

The machine? A WSi-200 Wire-Cut Submerge Type EDM from Tustin, CA-based machine tool company Kent USA.

# **Deep Discoveries**

"We primarily use the machine to cut material samples for testing and to slice 3D-printed parts off build plates," said Supreeth Gaddam, a graduate research assistant who is working on his doctorate and is currently in his fourth year of study. He explained that his primary area of



North Texas University researchers use wire EDM to cut dogbone-shaped samples from metal workpieces for analysis, as shown in this friction stir welding example.

interest is friction stir processing, but added that the lab in which the WSi-200 is situated—the Advanced Materials and Manufacturing Processes Institute (AMMPI)—delves deeply into materials science and various manufacturing technologies.

AMMPI is led by Gaddam's boss, Principal Investigator and Professor Rajiv S. Mishra. It is part of UNT's Department of Materials Science and Engineering, which also houses the Center for Agile and Adaptive Additive Manufacturing (CAAAM). According to UNT, Discovery Park-the home for these two research facilities-features nearly 300 acres of space dedicated to the sciences, technology and engineering and is the region's largest research park.

"UNT is a publicly-funded university with a broad curriculum, ranging from computer science and electrical engineering to the liberal arts, social sciences and much more," said Gaddam. "It is also designated as a Tier One university on the Carnegie rankings, which means we have a very high research output."

The WSi-200 Wire EDM is far from the only piece of manufacturing equipment at this forward-looking institution. Gaddam ticked off an impressive list of metal 3D printers, including laser powder bed fusion (LPBF) machines from Aconity3D and TRUMPF, and its latest addition, a solid-state metal printer from MELD Manufacturing that uses rod and bar stock rather than metal powder.



Ceramic-metal hybrid materials (cermets) are electrically conductive, a prerequisite for cutting workpieces with wire EDM.



The WSi-200 Wire-Cut Submerge Type EDM from Kent USA has provided the University of North Texas with years of consistent performance.



A pair of workpieces ready to be joined using friction stir welding, a solid-state process that provides superior weld quality with minimal part distortion.

It is this last machine, along with a friction stir welder from Manufacturing Technology Inc. (MTI), that consumes most of Gaddam's time. "Most of the work we do here is contracted projects, either from industry partners or one of the various government funding agencies. That is because we have the capability inhouse to carry out friction stir welding (FSW) and processing ourselves and then analyze the results."

### Give the Dog a Bone

Here again, the WSi-200 is a critical component in these efforts. With it, Gaddam and other researchers cut out small bits of metal known as "dog bones" that are then placed in testing machines and pulled apart, thereby quantifying the material?s tensile and yield strength. They also slice and crosssection test samples for micrography and, as noted, use wire EDM as a highprecision bandsaw to remove metal parts from their build platform after 3D printing.

"The friction stir process is where you take a rotating, dowel-like tool or piece of



The LENS Directed Energy Deposition (DED) machine from Optomec is one of several 3D printers at the University of North Texas, which researchers there study to better understand and thereby improve additive manufacturing technology.



Solid-state 3D printing technology from MELD Manufacturing was used to build this workpiece. Several test samples have been removed in order to analyze its metallurgical properties.

material, plunge it into the workpiece and then traverse across, heating the material and workpiece alike to temperatures just below their melting point as you go. This allows you to join two workpieces, enhance a part's mechanical properties, or, in the case of the MELD machine, continuously add material to build a 3D-printed workpiece."

In one example, an automaker might apply friction stir technology on an alloy wheel to reinforce certain areas. "Currently, the industry reinforces those sections by making them thicker, but with friction stir processing, we can specifically modify the microstructure in those regions that experience the highest amount of stress or fatigue loading and locally strengthen the material," said Gaddam. "This will lead to significant cost savings in terms of raw material, secondary machining processes, and to a certain degree, lightweighting."

The WSi-200 is an indispensable piece of equipment to Gaddam and many of the university's graduate students and other staff members. He noted that it was purchased before he came to AMMPI, but was transferred to the facility around one year ago. Kent USA Service Engineer Landon Gooding assisted with the move and recently performed preventive maintenance on the wire EDM's automatic wire threader (AWT).

"The EDM work we do here is fairly straightforward, but we could not proceed without it," said Gaddam. "In my experience, it has been a very good machine, and the service from Landon and the others at Kent USA has been excellent."

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