COLLISION WELDING INDUCED BY METAL VAPORIZATION

The Ohio State University (OSU) has a portfolio of impulse based welding, shaping, joining and forming technologies which have been developed through cutting edge research over the last 20 years with the direction of Dr. Glenn Daehn.

The Ohio State University researchers, led by Daehn and Anupam Vivek, have developed a variation of collision welding by electrically vaporizing thin metallic foils. Vaporization of the foil causes a rapid phase change which creates high pressure around the vaporizing conductor. This high pressure drives one metallic plate towards another at high speed and the resulting impact causes the materials to weld together. Formation of jet results in uncontaminated metal surfaces which form an atomic bond upon contact. Wavy interfaces, typically observed in traditional explosion welds (EXW), are attained. As opposed to current technologies, this technology requires fewer safety standards and significantly reduces energy consumption.

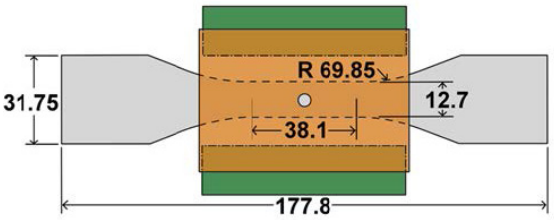
THE TECHNOLOGY

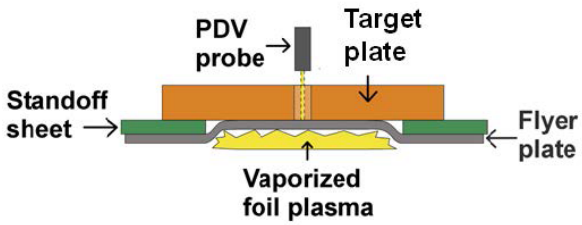
Vaporizing foil actuator (VFA) metalworking was developed to carry out impulse processes on a small scale, without sharing the limitations of other impulse techniques. In this technique, an aluminum foil actuator is electrically vaporized by means of a capacitor bank. The rapid vaporization generates a high pressure pulse which propels the work piece (the flyer) to a high speed for impulse metalworking. This technology directly competes with Electromagnetic Forming (EMF), which operates on the same length scale as VFA. This process involves no explosives and is designed to operate on a small scale with fairly light tooling. The actuator is expendable and is replaced inexpensively between cycles, so the longevity of the actuator is not an issue. Vaporizing foil actuator metalworking involves fairly light tooling and is capable of a range of metal-working tasks.

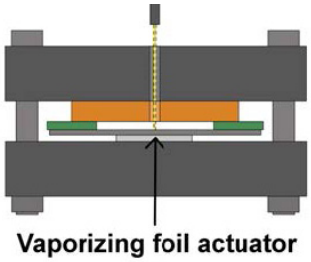
APPLICATIONS

VFA technology can be used for solid state, dissimilar, metal joining that is ideal for low volume production. It enables high strength welds between materials that are currently considered to be non-weldable by traditional fusion welding techniques.

VFA technology can also be used in impact welding dissimilar metals, in the joining of metals, embossing and forming operations, elastic recovery or springback calibration, and powder compaction.







INVENTORS

Glenn S. Daehn is a Professor in the Department of Materials Science and Engineering at The Ohio State University and is designated the Mars G. Fontana Professor of Metallurgical Engineering. His research group has been actively developing electromagnetic metal forming technologies for the past 20 years. He is one of the founding members and Chair of the International Impulse Forming Group. He currently leads the Impulse Manufacturing Laboratory at OSU. Dr. Daehn was named a National Young Investigator by NSF, was recipient of the Hardy Medal of TMS (1992), and named a Fellow of ASM in 2010. Dr. Daehn's academic training includes a BS from Northwestern University (1983), and MS and PhD degrees from Stanford University (1987), all in Materials Science and Engineering.

Anupam Vivek received his B. Tech degree in Manufacturing Science and Engineering from Indian Institute of Technology at Kharagpur, India in 2007. His senior project was on high speed machining of Inconel-718 and Ti6Al4V. He joined Professor Daehn's group in 2007 to pursue an MS degree, but decided later to continue as a PhD candidate. Initially he worked on electromagnetic compression and expansion of steel and aluminum tubes and constitutive property of materials. Most of his doctoral work, however, consists of development of various metalworking operations based on the vaporizing conductor method.

KEY FEATURES AND BENEFITS

- Impact welding of dissimilar metals: no explosives, automated, higher velocities reached, wider range of metals can be welded, actuator lifespan is improved, the process is scaled down to an industrial setting, and there are no brittle alloys or heat affected zones
- Conformal joining of dissimilar metals: matched tool and die sets are not required and there is a smaller equipment footprint.
- Embossing and forming: smaller equipment footprint, improved formability, sharper features, and one-sided tooling
- Springback calibration: no heat treatment cycling needed, single-step calibration, and single-sided dies.
- Powder compaction and foams: much higher densities achieved and no chemicals or fluids in the foam making process

MARKET OPPORTUNITIES

- Estimates from Dynamic Materials Corp. have shown that the size of global explosion welding market was $550M in 2007.
- Demand for welding equipment and consumables in the U.S. is expected to increase 6.4% annually to $7.1B in 2015, driven by continued recovery of the economy and manufacturing.
- Overall, the market for explosion-welded clad metal has continuously grown since its inception, with demand dependent upon the underlying needs of the various market sectors.

THE OHIO STATE UNIVERSITY

CDME is supporting the commercialization of technologies that emerge from Ohio State's annual research efforts. Ohio State has one of the largest research and development budgets of all universities. The amount of annual funding is a leading indicator of the breakthrough innovation occurring within the University. Recent annual highlights from OSU:

» $934 Million: Total research and development (R&D) expenditures

» $470 Million: Federal R&D expenditures

» $101 Million: Industry-sponsored research expenditures

Whether your interest is in licensing, sponsored research, joint ventures, investment, corporate giving or placement of our best students, Ohio State is here to help accelerate your business through innovation.

Intellectual Property

US Patent 8,084,710
US Patent 6,128,935
US Patent 6,047,582
US Patent 6,050,120
US Patent 6,227,023
US Patent 6,085,562
US Patent 6,050,121

Categories

Manufacturing, Welding, Joinery.

College

College of Engineering (COE)
Department of Materials Science and Engineering (MSE)

CONTACTS

CDME

1314 Kinnear Road, Columbus OH, 43212
cdme.osu.edu

Eric Wagner, Collaboration Manager
wagner.293@osu.edu • 614-477-0303

Ohio State University, MSE

Glenn S. Daehn, Professor
daehn.1@osu.edu • 614-292-6779

Technology Commercialization Office

Jason "Jay" Dahlman, Licensing Manager
dahlman.3@osu.edu • 614-292-7945