

An application of PDV in impact welding process

Huimin Wang, Geoff Taber, Glenn Daehn

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Outline

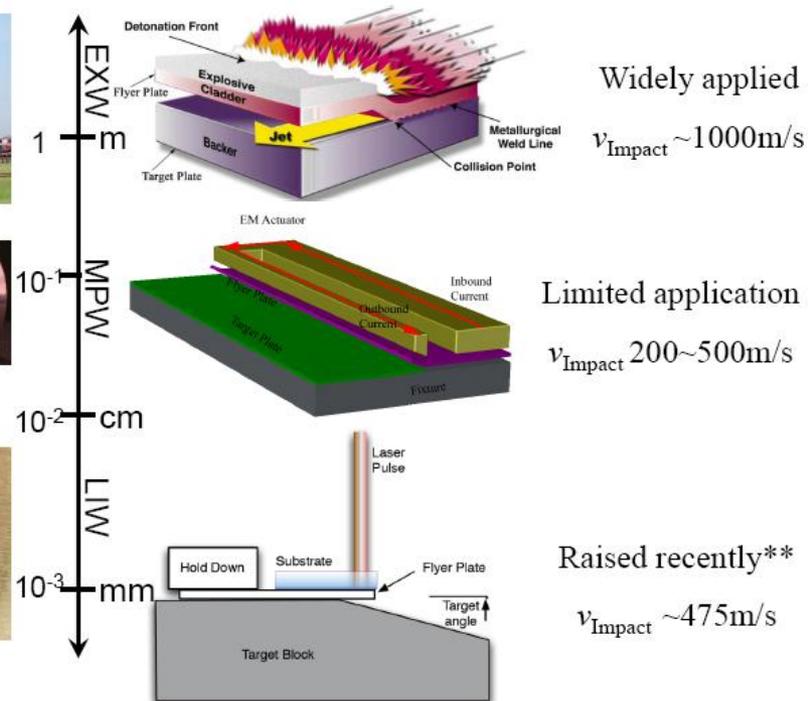
- Introduction and motivation
- Welding mechanism and PDV application
- Magnetic pulse welding
 - Experimental setup
 - Experimental result
- Laser impact welding
 - Experimental setup
 - Experimental result

Introduction and Motivation

- Impact welding is a kind of solid state welding.
- Mainly used to join dissimilar materials which are difficult to be welded using fusion welding.
- Explosive welding, magnetic pulse welding and laser impact welding are included.
- No heat affected zone.



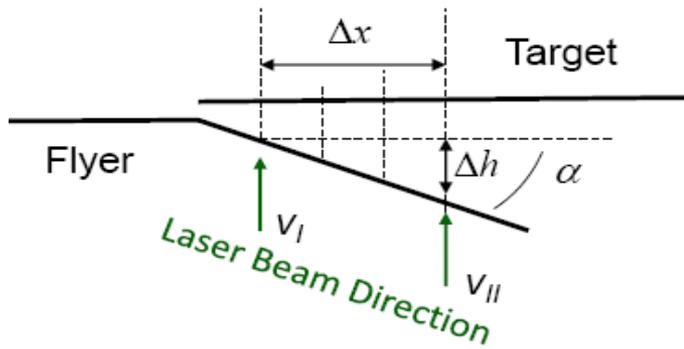
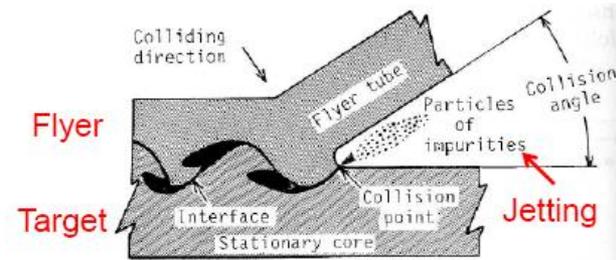
Diameter for a quarter is ~24mm.



[*Y. Zhang et al., 2010; **G. Daehn and John Lippold, 2009]

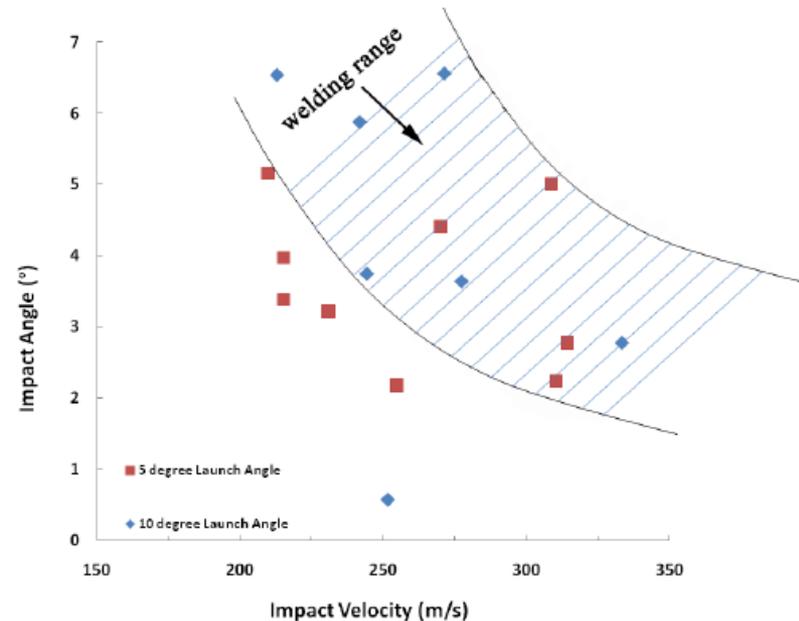
Welding mechanism and PDV application

- Material jet formed at the collision point
- Oxide layers removed
- Fresh metal within atomic distance
- Metallurgical bond formed
- Impact angle and impact velocity are critical



$$\alpha = \text{tg}^{-1} \frac{\Delta h}{\Delta x}$$

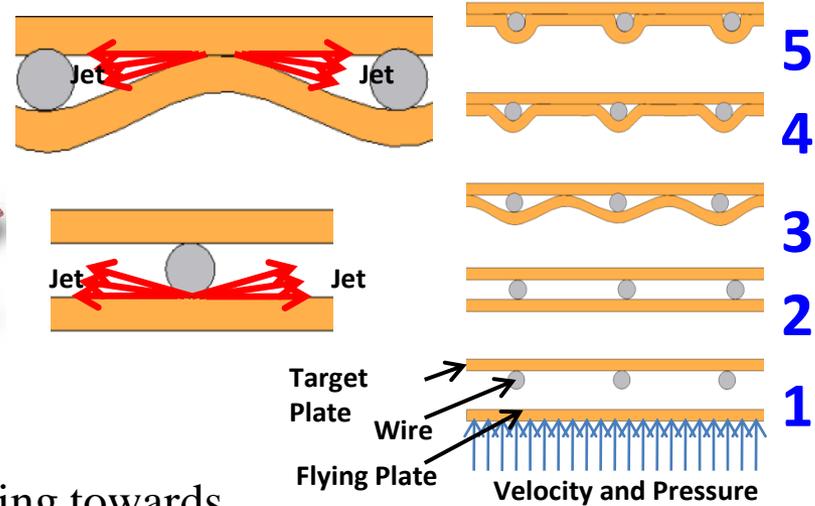
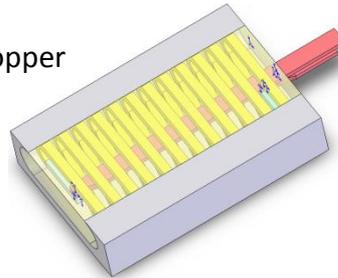
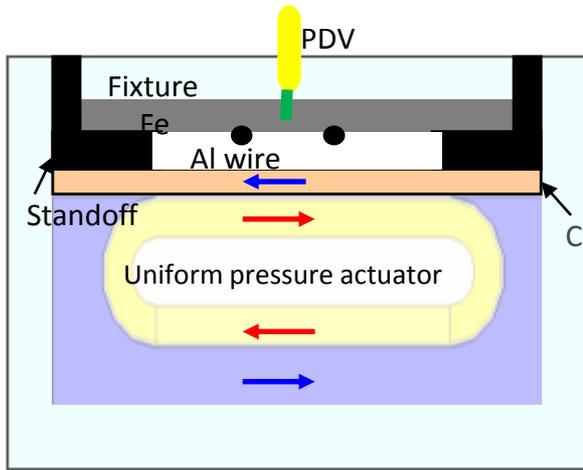
$$\Delta h = \int v_{II} dt_{II} - \int v_I dt_I$$



Joining map for Cu10 joints of 0.254mm thick plates

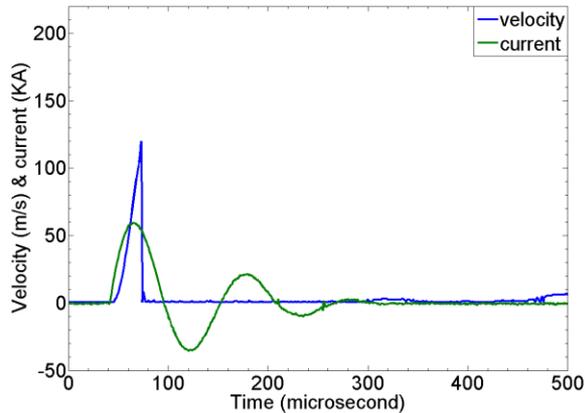
Magnetic pulse welding

Experimental setup

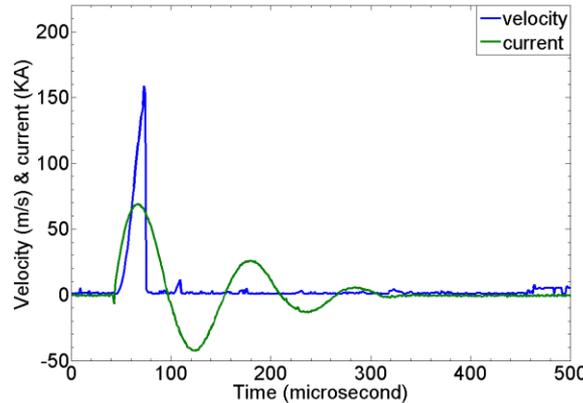


Magnetic force accelerates one plate (flyer) flying towards another plate (target). After the collision, metallic bond is formed

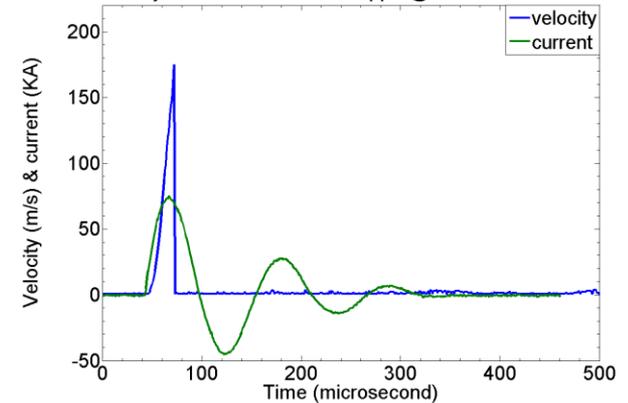
velocity and current curve of copper@1.6KJ-2mm standoff



velocity and current curve of copper@2.4KJ-2mm standoff

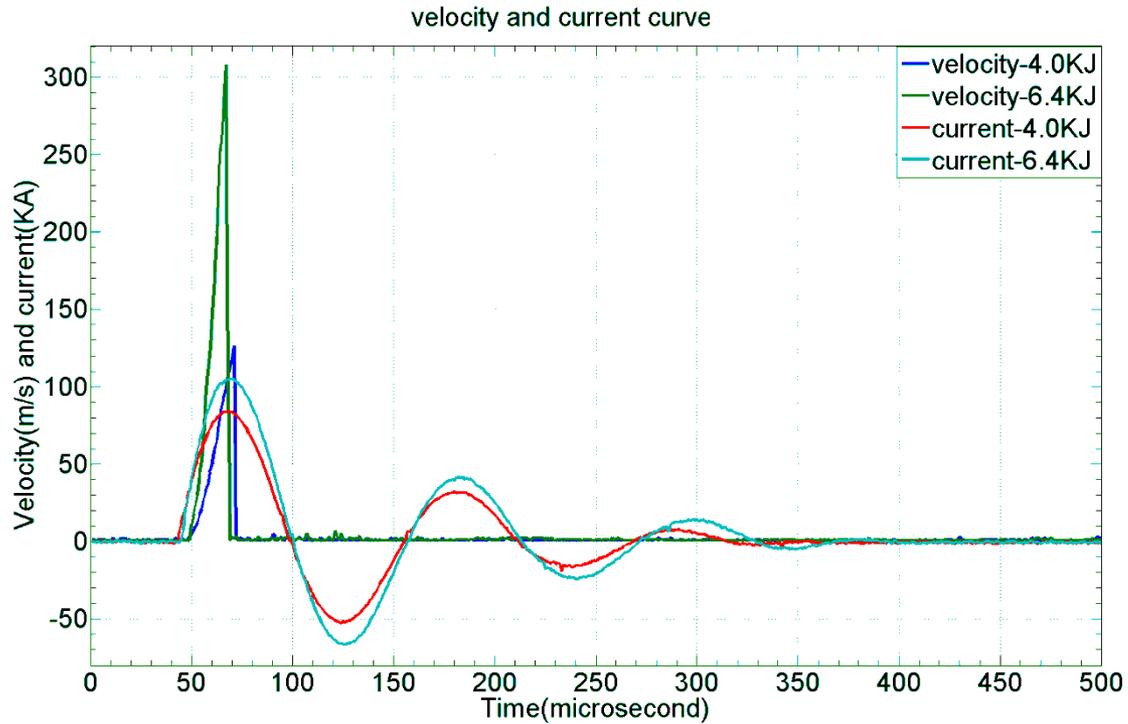


velocity and current curve of copper@2.8KJ-2mm standoff



Magnetic pulse welding

Experimental result

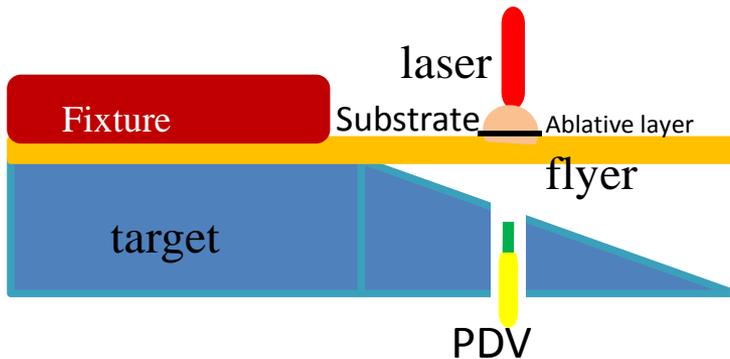


Flyer	Target	Energy (KJ)	Flyer thickness	Target thickness	Standoff
Cu110	Low carbon steel	6.4	0.01"	0.025"	2mm



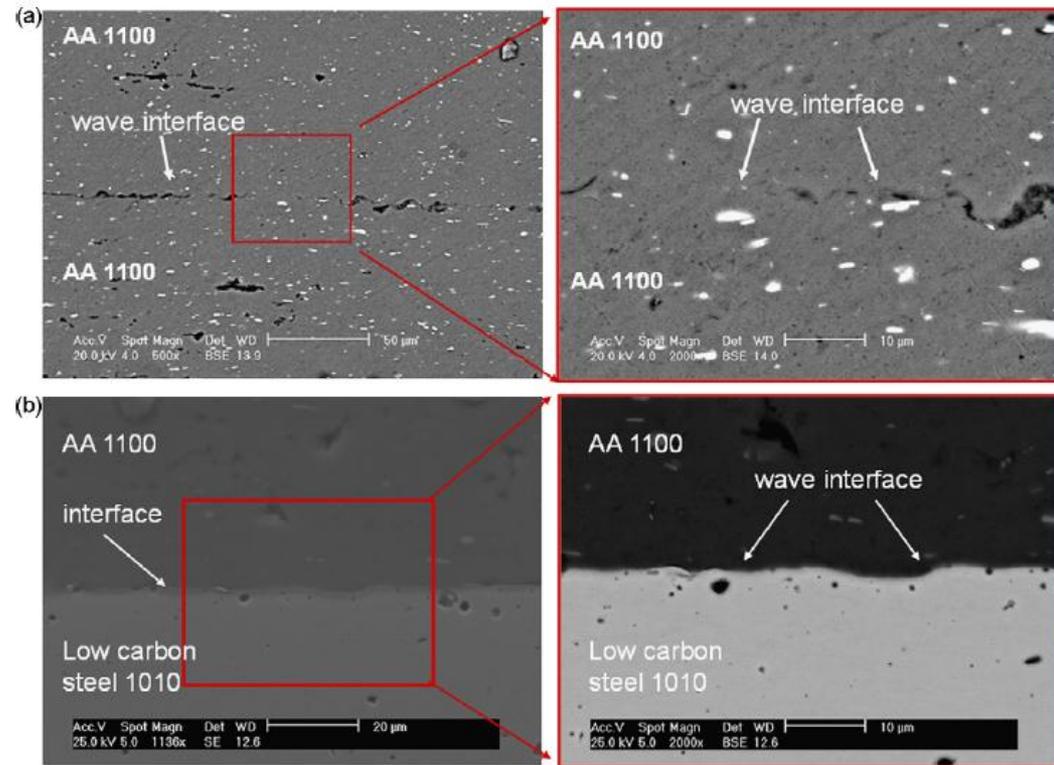
Laser impact welding

Experimental setup



Laser type: continuum laser and pulse laser
Laser ranges from 1-100 Joules
The impact occurs in excess of 100m/s

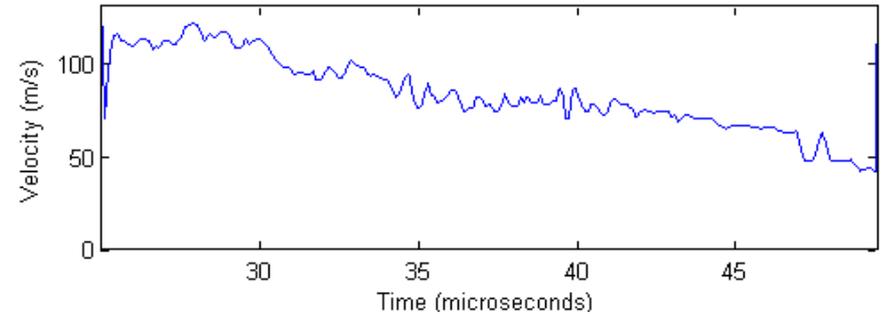
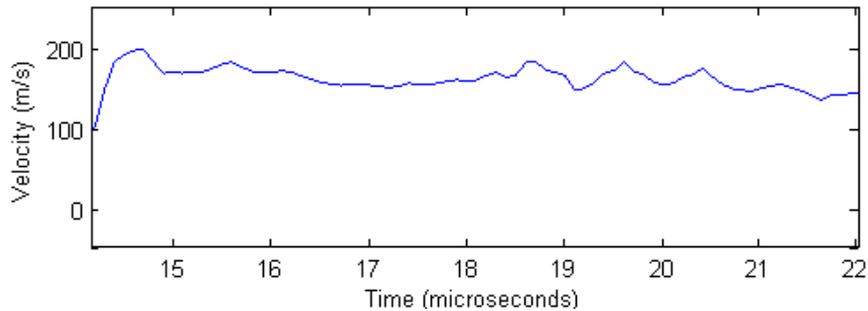
Laser caused the flyer flying towards the target. The interaction between the laser and substrate will enable the substrate momentum which will augment the joining. Ablative layer will protect the flyer burned by absorbing the optical energy. And plasma-based pressure generated from the ablative layer will accelerate the flyer. When the flyer collide the target during pressure pulse, material jet will form. Metallic bond will be accomplished when two clean metal surface meet at the pressure.



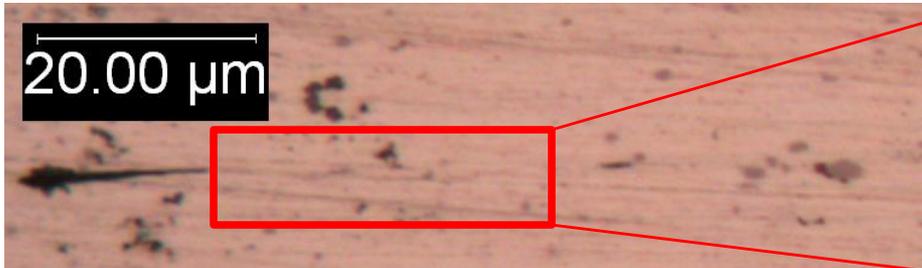
Laser impact welding

Experimental result

Exp. No.	flyer	Energy (J)	Flyer thickness	Substrate
1	Al6061-T6	6.5	0.025''	water
2	Al6061-T6	6.5	0.025''	tape



Flyer	Target	Energy (J)	Flyer thickness	Target thickness	Substrate
Al1100	Al1100	6.1	0.003''	0.003''	water



Questions?