Mechanical Characterization of Bulk Metallic Glasses

OKLAHOMA STATE UNIVERSITY

Valentin F. Sanchez OSU, S. Habib Alavi OSU
Dr. Sandip Harimkar MAE Professor OSU

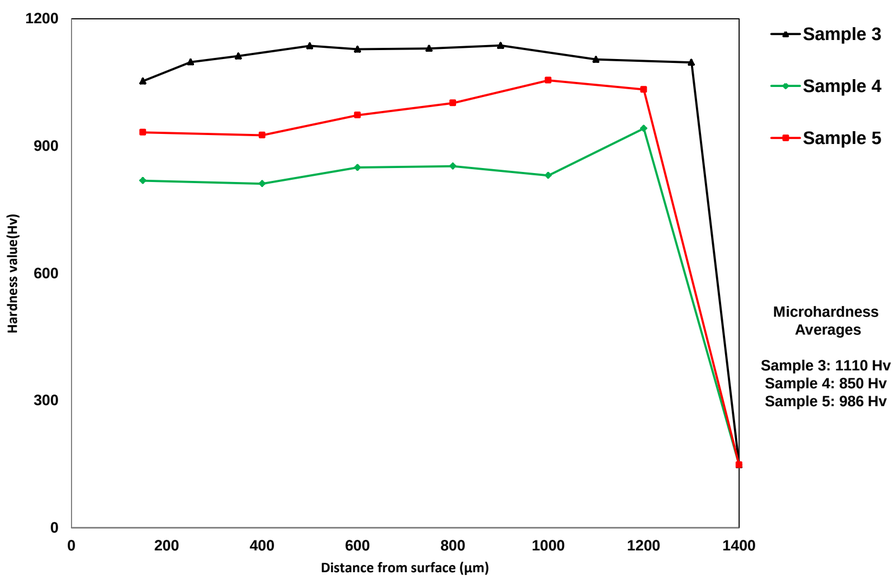
Abstract: This research studies the mechanical properties of laser-welded bulk metallic glasses to a steel substrate. Samples were prepared at various processing parameters for peak bonding conditions. This study focuses on the correlation of hardness and welding depth and dendrite arm spacing at varying depths of the heat affected area.

Introduction: Laser Welding is a high precision, and relatively low energy-consumption method of processing materials. Bulk metallic glasses (BMGs) are super-cooled alloys that demonstrate high strength and conductivity properties. Proper bonding is essential, so, mechanical properties are investigated for the samples. The BMG in this study is contains Fe-Si-B.

Sample Parameters

No	Energy (W)	Speed (mm/S)	Mode	Beam Size (mm)	Condition	Size
1	800	20	L	0.6	Not Good	
2	1000	20	L	0.6	Good in a tiny parts	
3	1000	10	L	0.6	Good	
4	1000	10	Zig Zag	0.6	Very Good	Width=3200 Depth=1400
5	900	10	Zig Zag	0.6	Very Good	Width=3250 Depth=1350

Hardness vs. Welding Depth



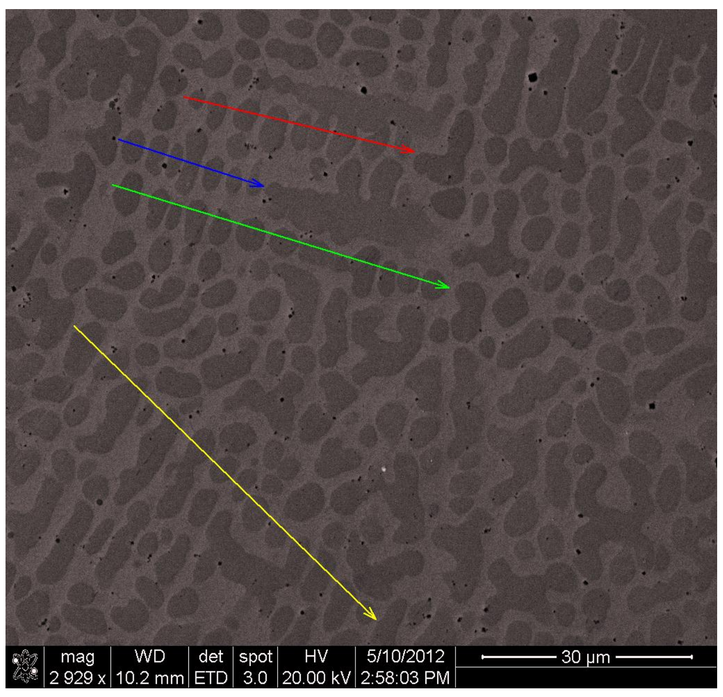
Sample 4		
Location	Avg. Spacing (µm)	Avg. Hardness (HV)
top	2.5	815
middle	4.1	851
bottom	4.7	886

Sample 5		
Location	Avg. Spacing (µm)	Avg. Hardness (HV)
top	2.77	929
middle	2.75	987
bottom	5.34	1044

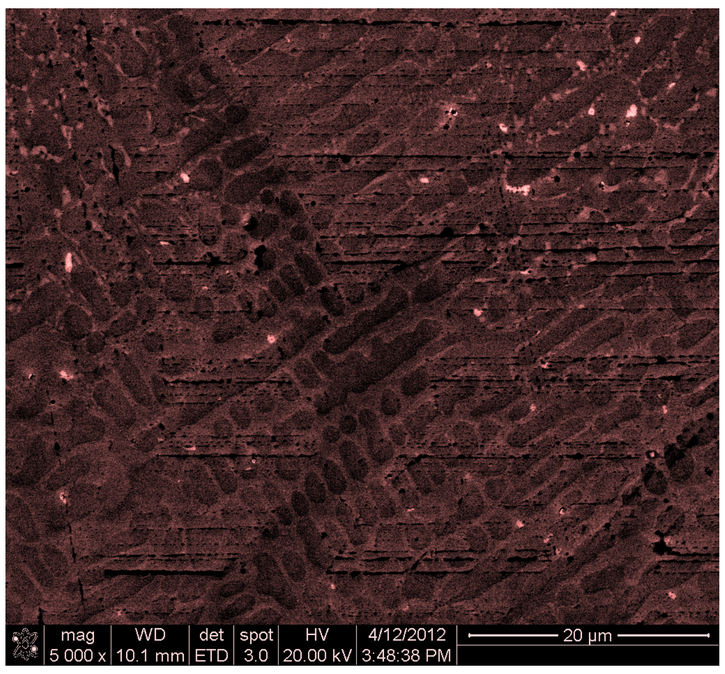
Nd: YAG Laser

SEM Images

1000 Watts



900 Watts



Conclusions: Initial measurements suggest an increase in hardness with welding depth as well as an increase in dendrite-arm spacing with depth. Additional tests need to be conducted on order to strengthen the data and average out errors. Future tests include conductivity, corrosion, and wear tests.

- The sample is cut in half then the cross-section is polished and etched.
- SEM images are used to take dendrite arm spacing measurements at the top, middle, and bottom of the heat-affected area.
- Hardness values are taken using a micro-hardness indenter.