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A New Method to Make Unidirectional Porous Structure by Explosive Welding Technique

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DIVISIONS & SECTIONS

Pulsed Power Infrastructure Department
Pulsed Power Generation Control Laboratory
Explosive Process Laboratory
Supercritical Fluid Process Laboratory
Environmental Process Laboratory

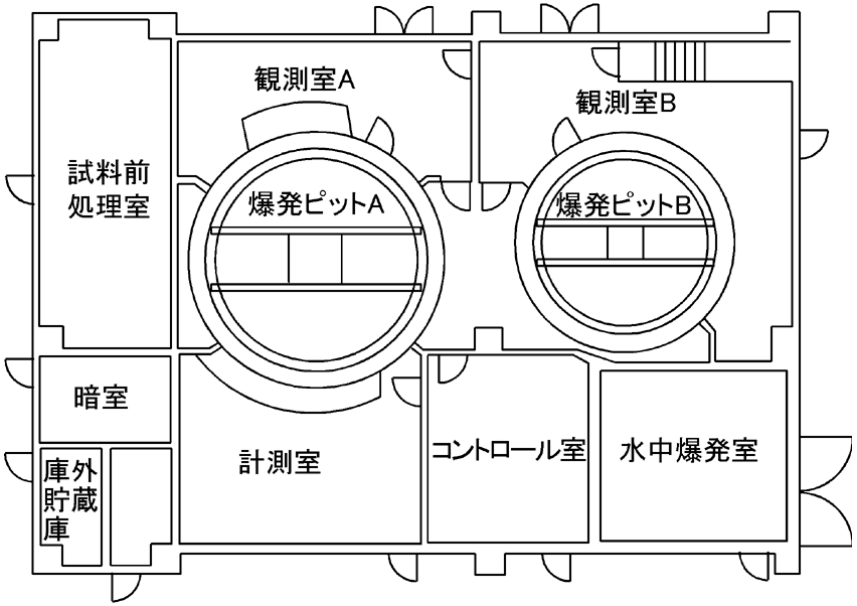
Extreme Condition Materials Science Department
Shock-Compression and Strong-Gravity Materials Science Laboratory
Condensed Matter Physics under Extreme Conditions Laboratory
Extreme Material Science Laboratory
Semiconductor Extreme Function Science Laboratory

Bioelectrics Department
Bioelectrics Fundamentals Laboratory
Applied Bioelectrics Laboratory
Medical Bioelectrics Laboratory
Shockwave Bioelectrics Laboratory

International Visitor Liaison Department

Kumamoto University

Explosion experiment facility (10kg max.) Since 2001



High-speed video camera
1μs (100 frames)

Outside

Under water chamber

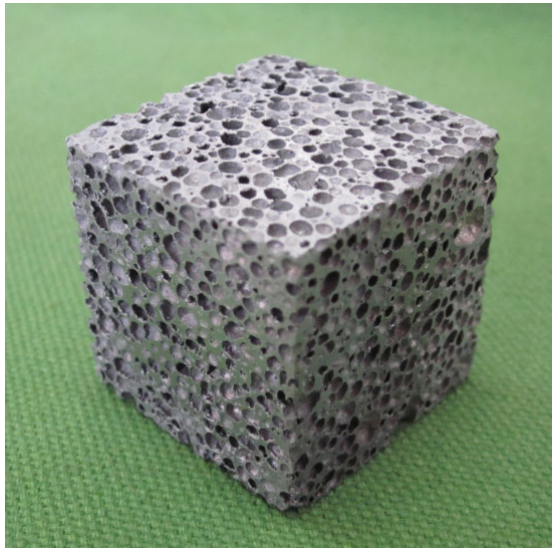
A pit (>2000 pers x d/y)

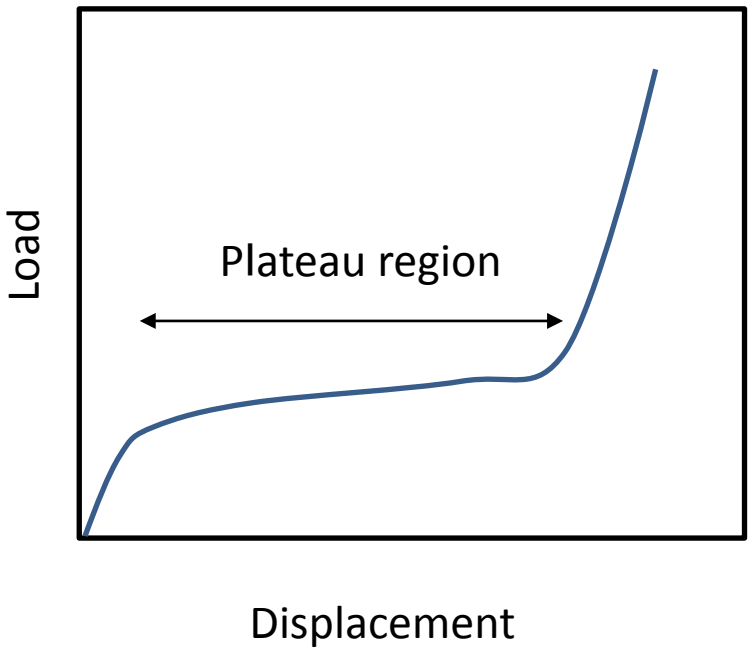
Other facilities ; Powder gun, High-capacity condenser bank

Porous materials

Light-weighted, Damping, Noise reduction,
Energy absorption at impact loading

Artificial bone, heat sink, aircraft and car parts





http://www.zhaowmgroup.com/item.php?id=16

Lotus type porous metals through one directional solidification

Prof. Nakajima, formerly, Osaka University developed Lotus type porous materials using solidification of molten metals inserting gas for making elongated pores in one direction.

*Un-isotropic properties

*Pores are partially connected

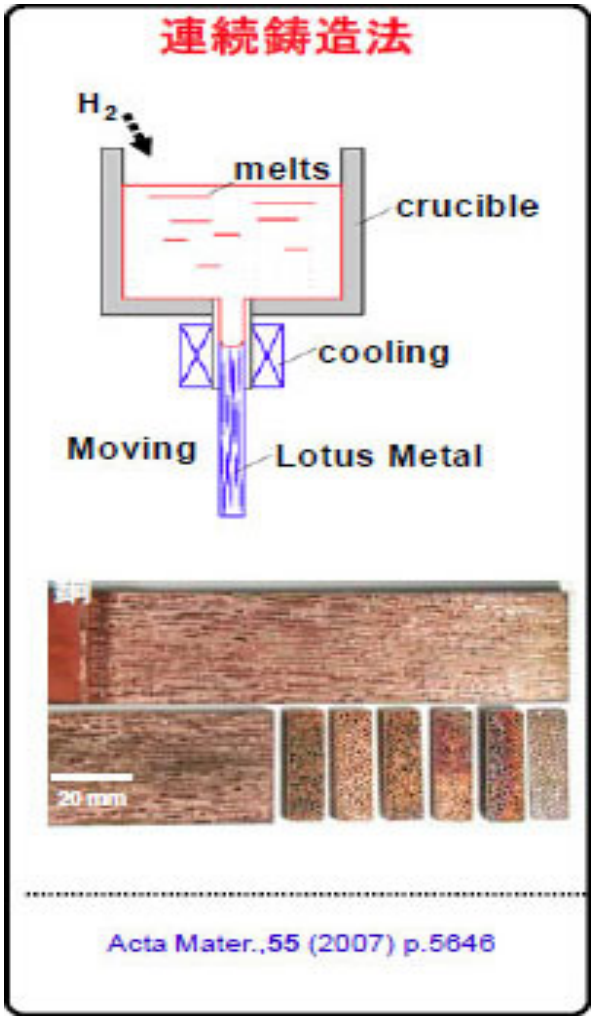
*Non-uniform size of pores

Possible to use as

Heat exchangers and other related parts

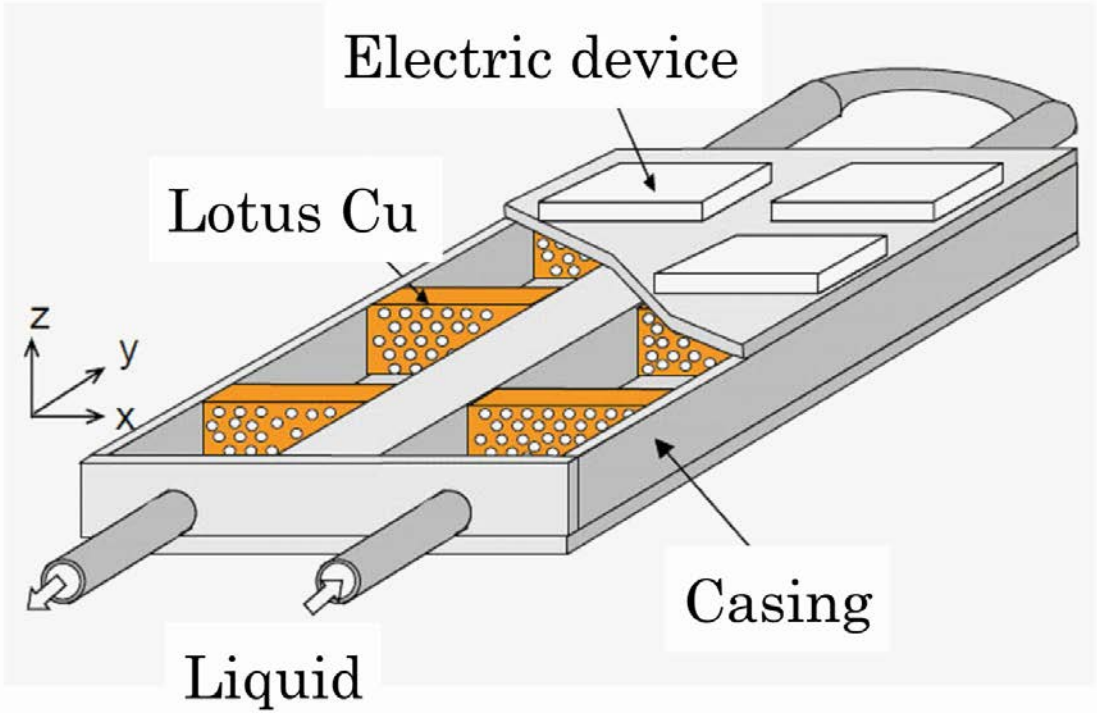
Energy absorption at impact loading

http://www.lotus-alloy.jp/assets/images/works/zu02.jpg

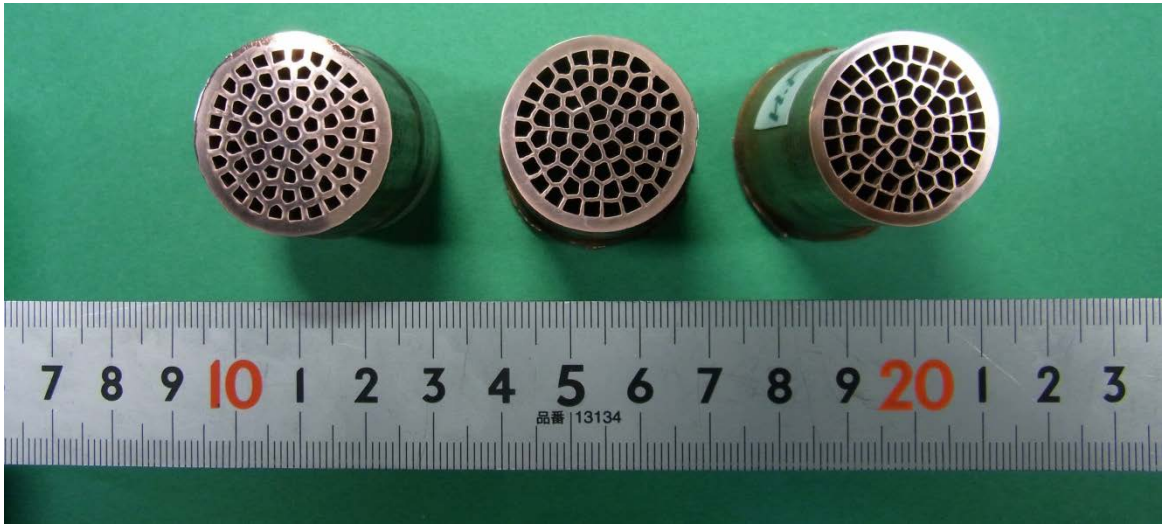


http://www.lotus-alloy.jp/61.html

Heat sink part



UniPore structure
Pores are uniform and isolated by walls.

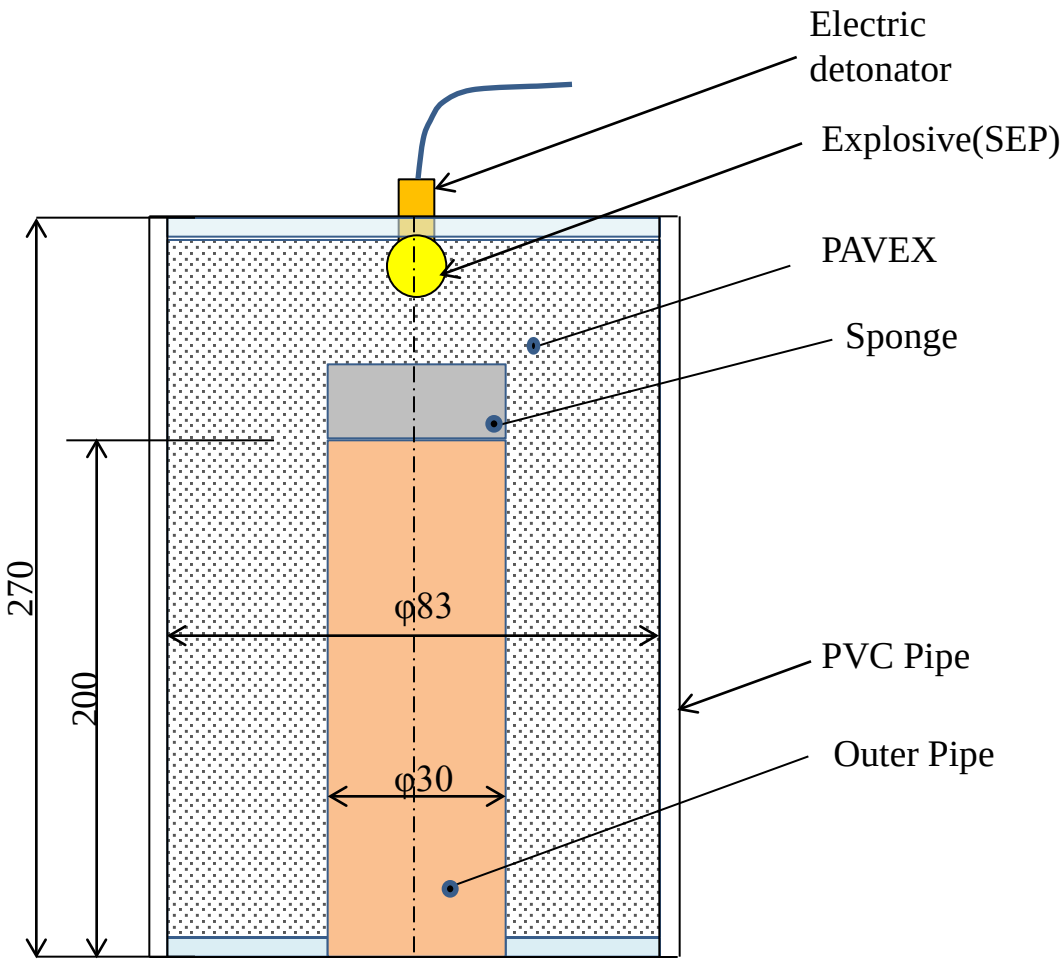


Objectives

- Method to obtain such unique structure
- Microstructural characterization including hardness measurements
- Compression test results

Experimental apparatus for explosive compaction for making UniPore structure

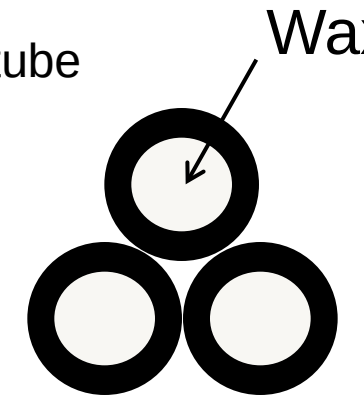
	PAVEX	SEP	ED
Quantity	750g	10g	1
Detonating velocity	2000m/s	6800m/s	
Density	550kg/m^3	1310kg/m^3	

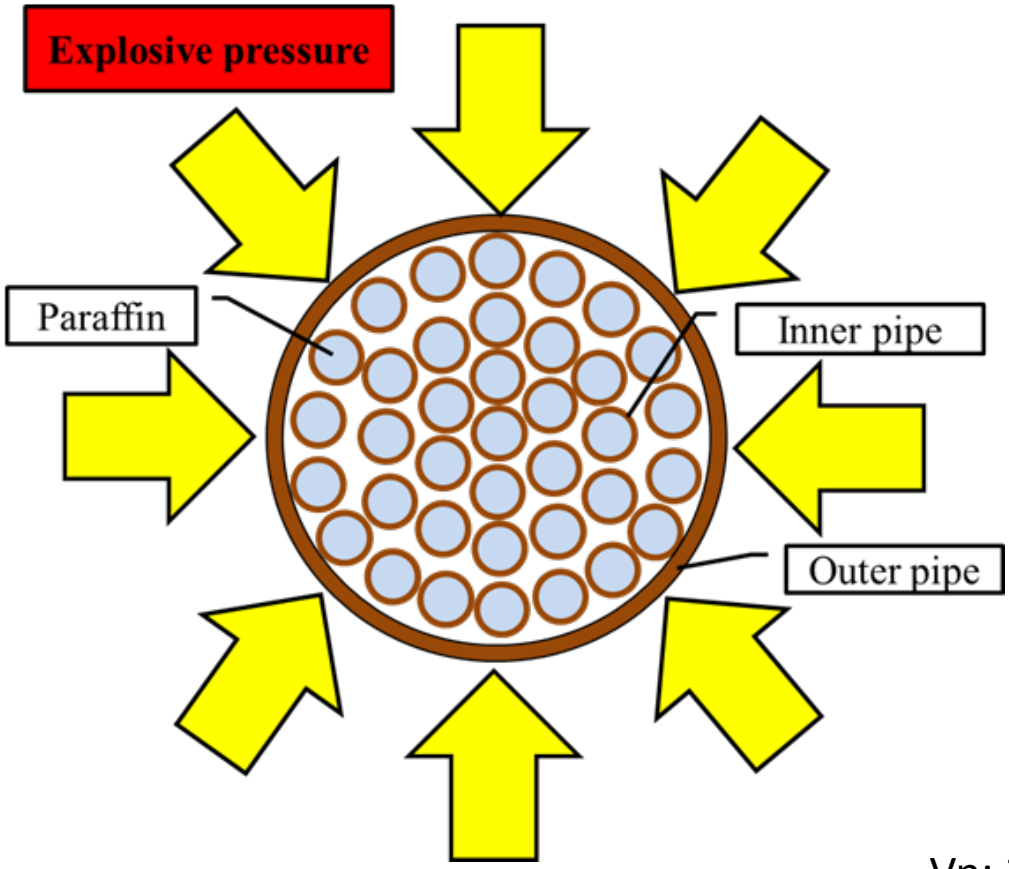


Experimental conditions

	Inner pipe			Outer pipe	
	Outer diameter φo[mm]	Internal diameter φi[mm]	Number	Outer diameter [mm]	Internal diameter [mm]
Low porpsity	3.0	2.0	65	30.0	27.0
Middle porpsity		2.4	63		
High porosity		2.6	63		

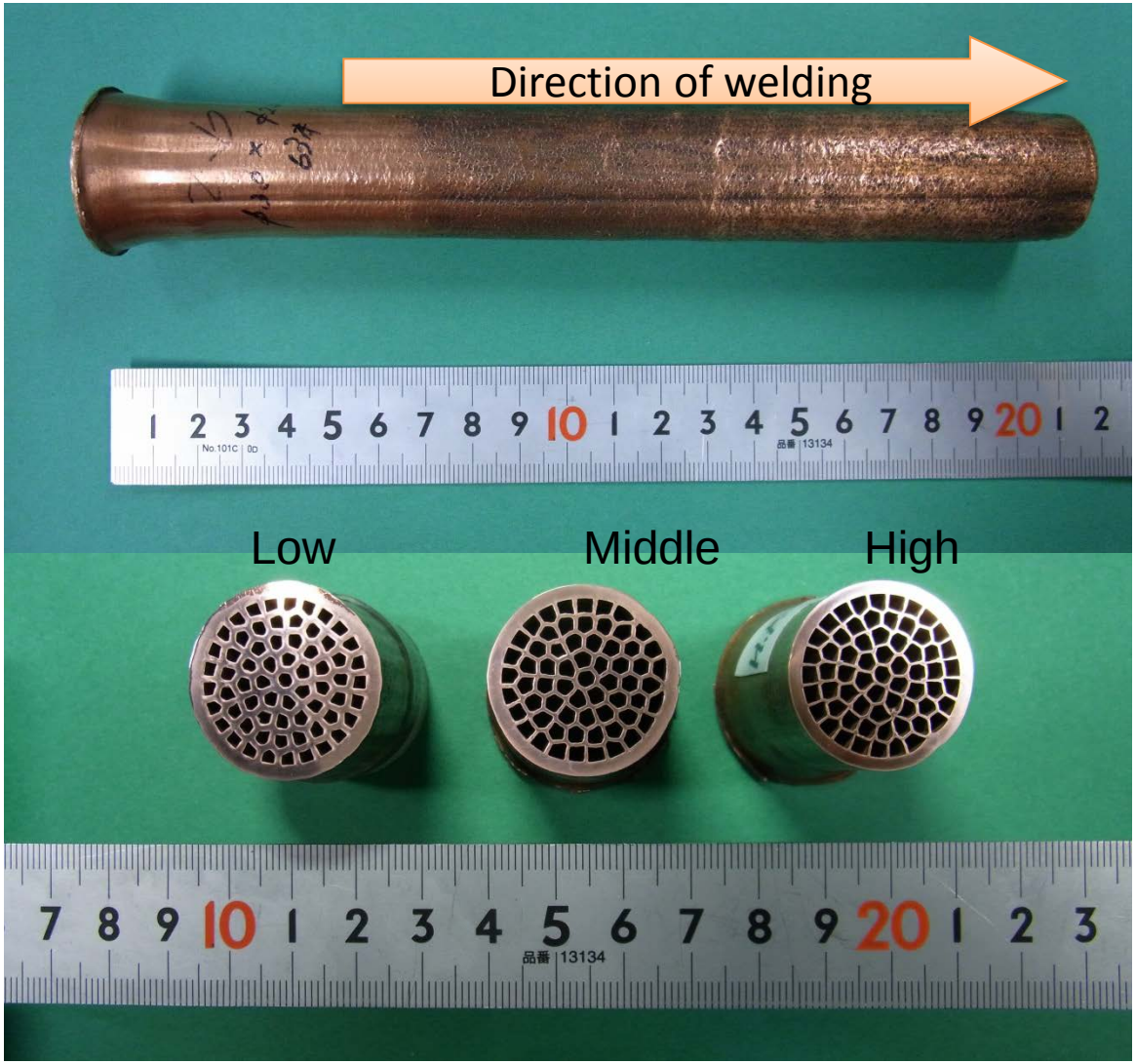
Wax in inner tube





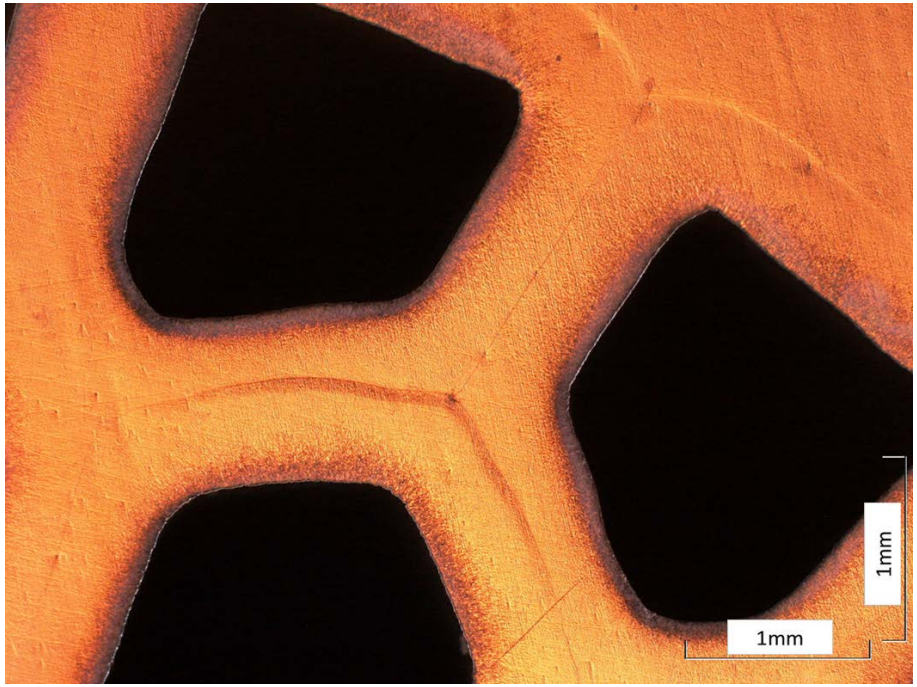
Vp: 200-300m/s

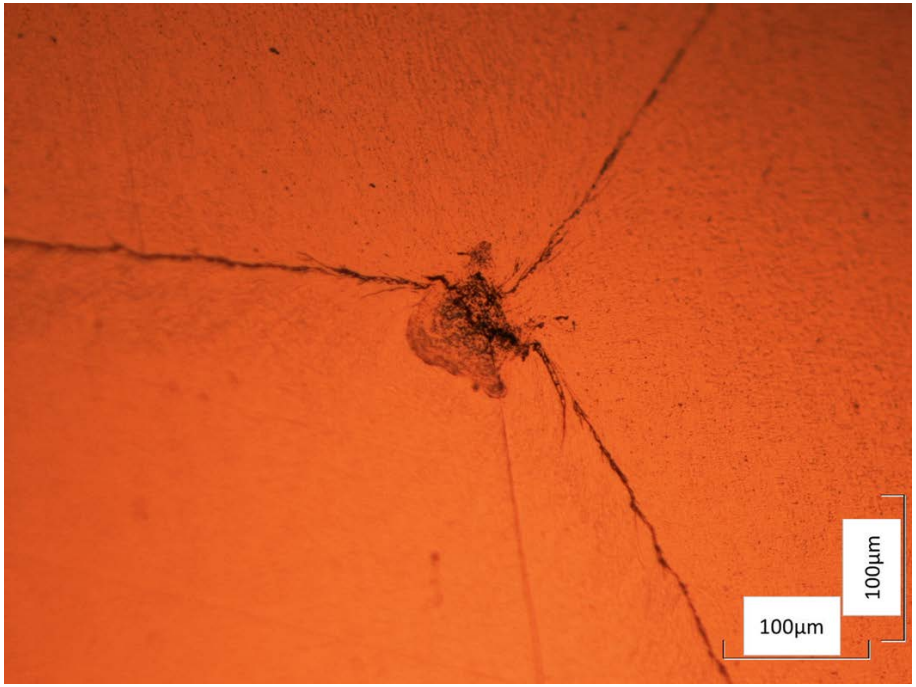
Recovered samples



Cross-section

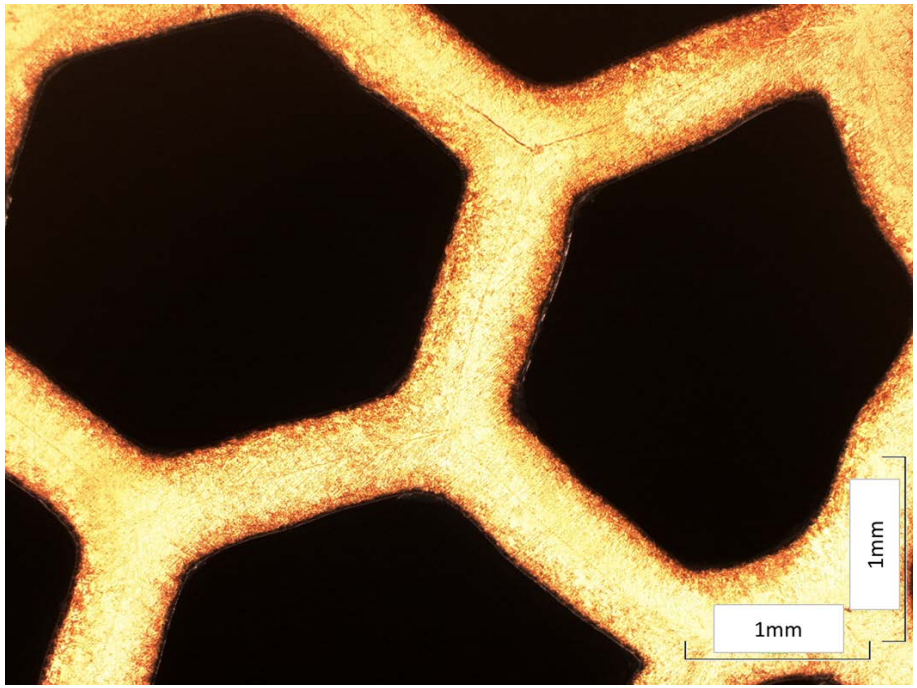
Low porosity（Pipe wall thickness 0.5mm）

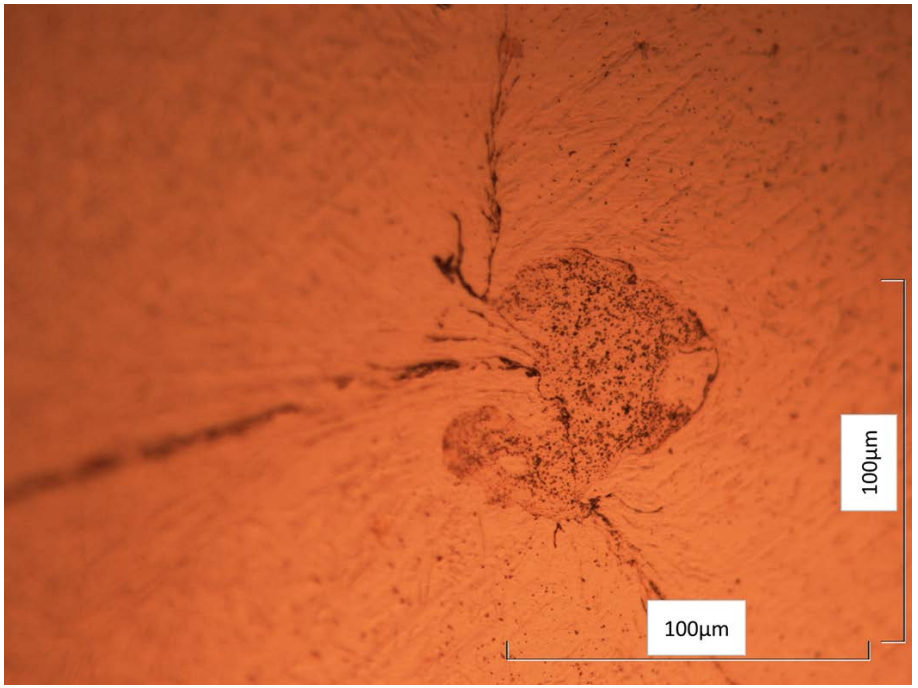




Cross-section

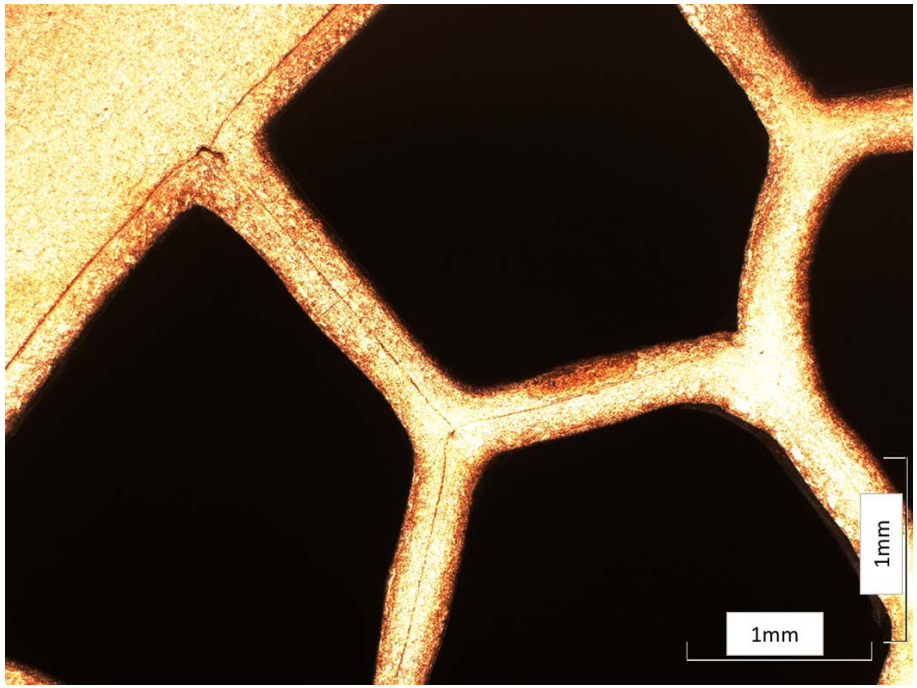
Middle porosity（Pipe wall thickness 0.3mm）

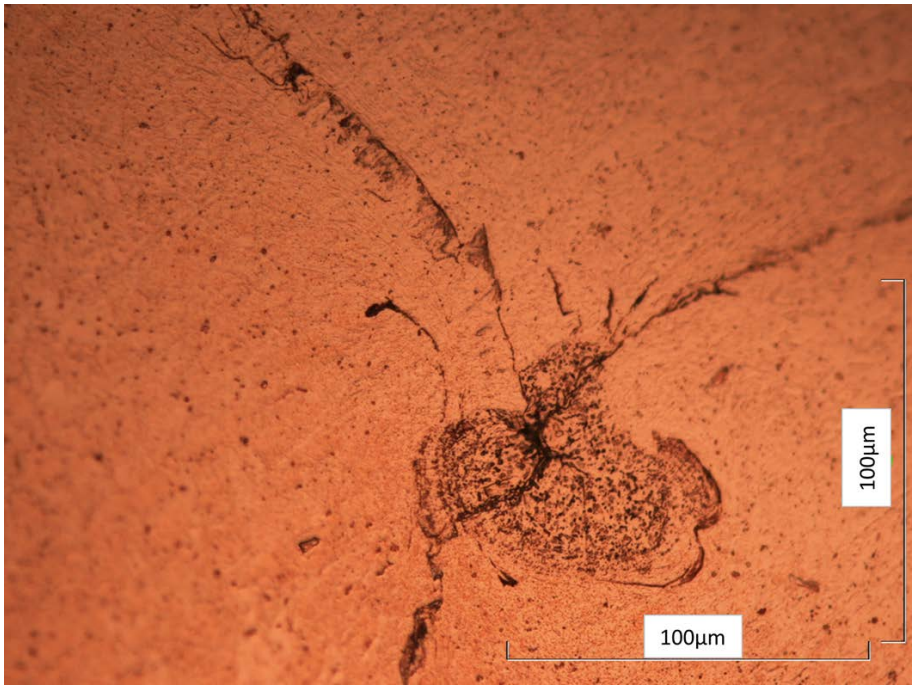




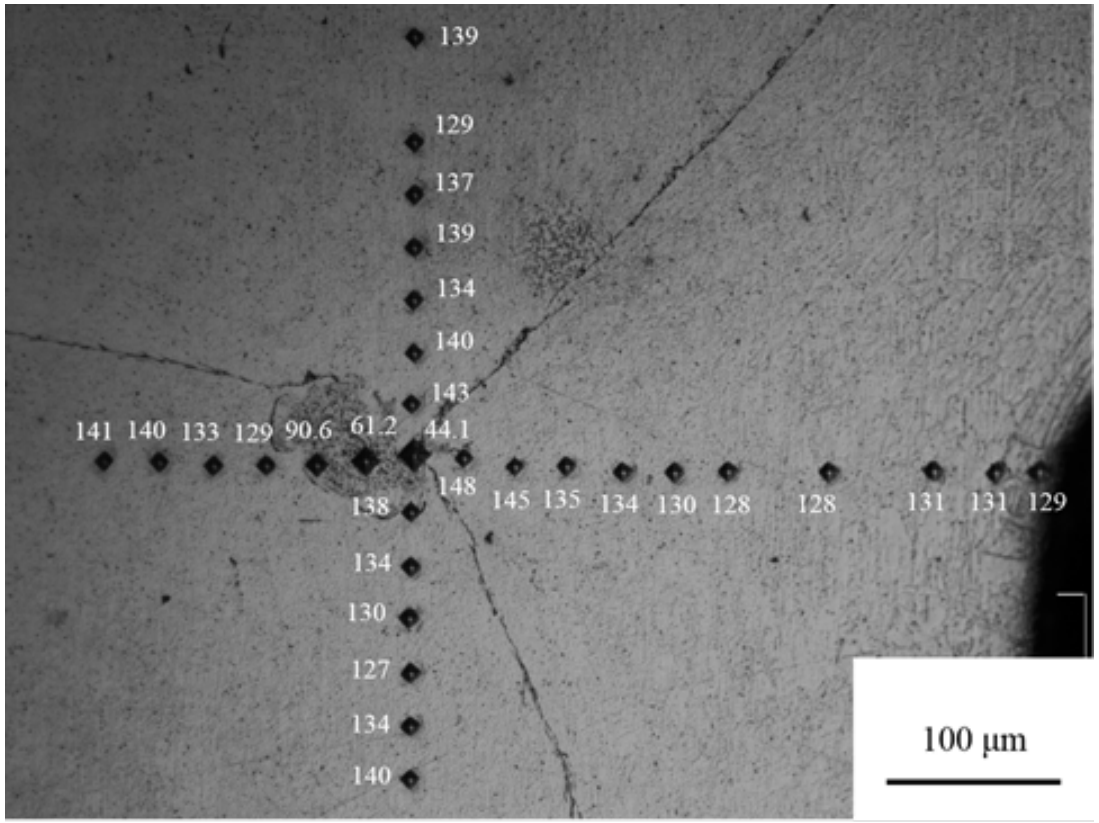
Cross-section

High porosity（Pipe wall thickness 0.2mm）



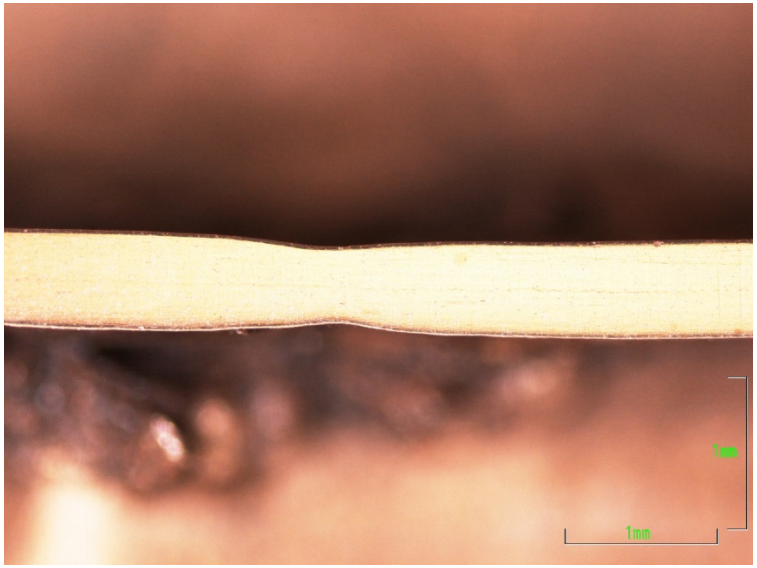


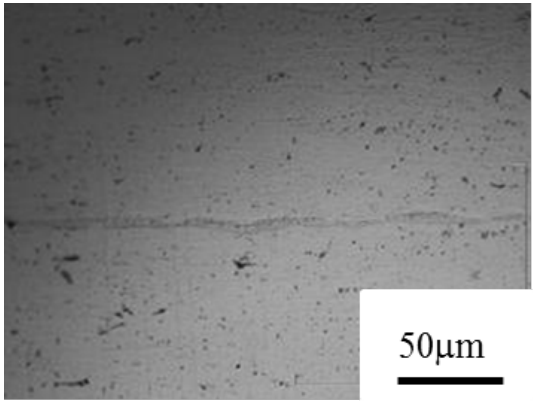
High porosity（Pipe wall thickness 0.2mm）

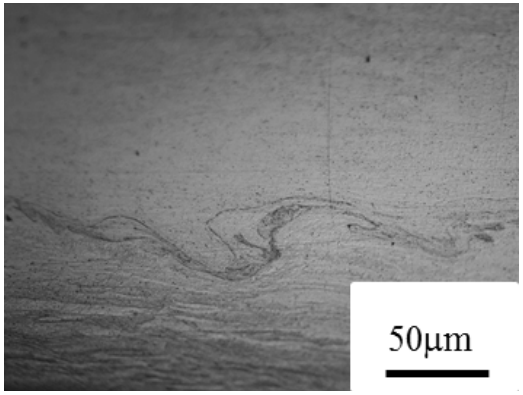


Longitudinal cross-section

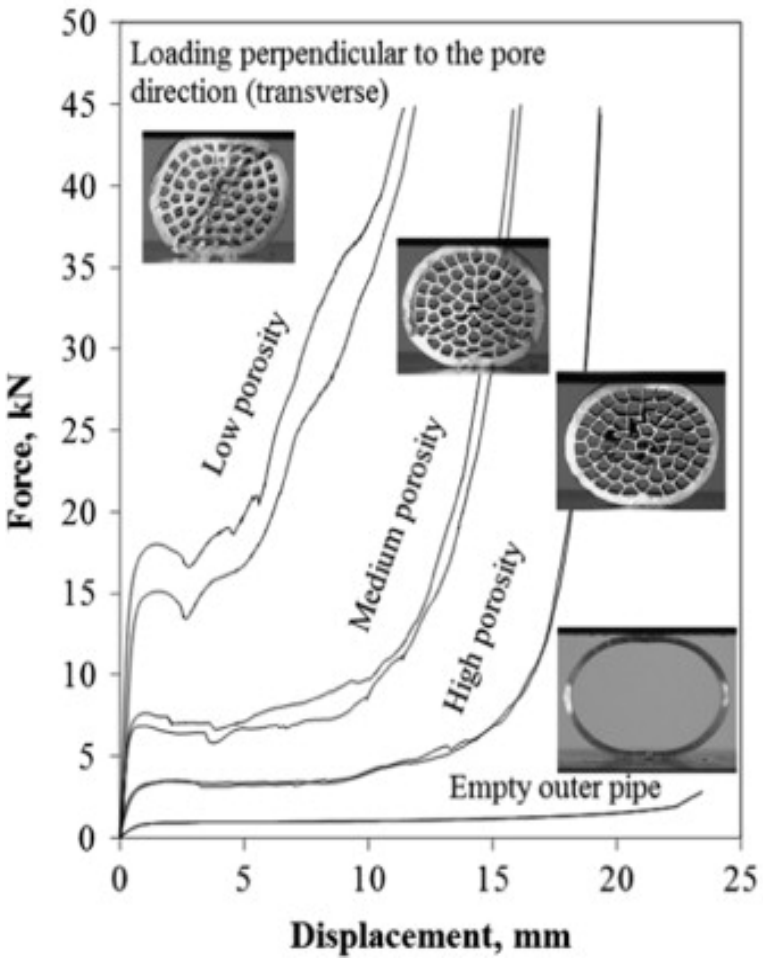
High porosity（Pipe wall thickness 0.2mm）

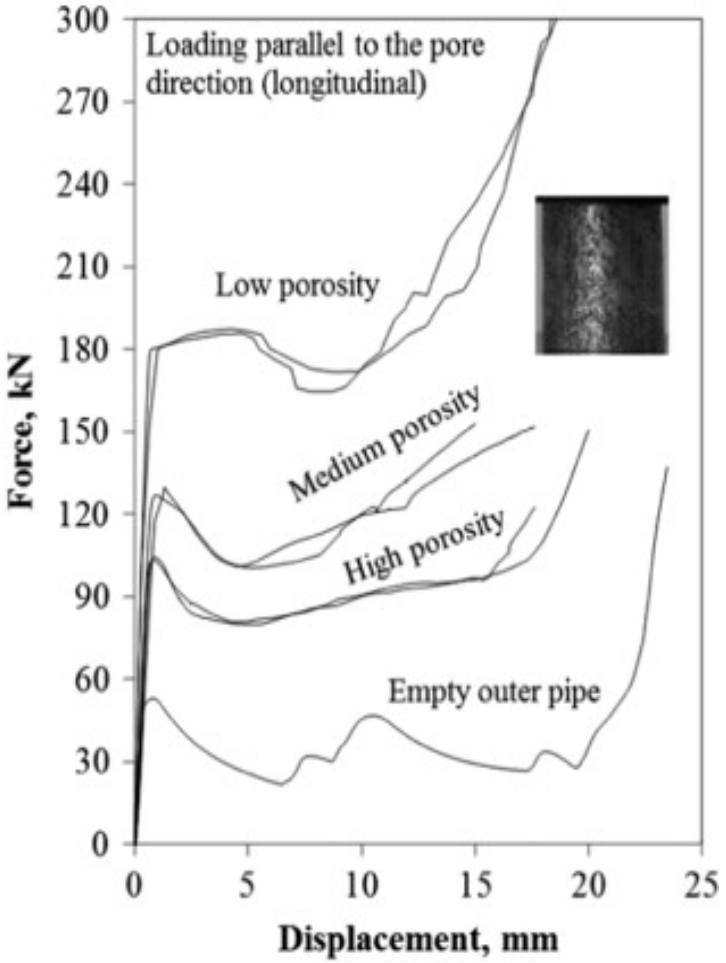






Compression tests (27mm-thick)





Summery

A modified explosive welding technique using cylindrical geometry to fabricate UniPore, unidirectional pored structure, is demonstrated.

The cross-sectional view showed quite uniform pored structure and each pore was perfectly isolated by the wall of small pipes with tight bonding based on the activation by metal jets.

The practical application of the unique material is being investigated.

Acknowledgements

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References

K.Hokamoto, M.Vesenjak, Z.Ren: “Fabrication of cylindrical uni-directional porous metal with explosive compaction”, Materials Letters 137, 323-327, 2014.

M. Vesenjak, K. Hokamoto, M. Sakamoto, T. Nishi, L. Krstulović-Opara, Z. Ren: "Mechanical and microstructural analysis of unidirectional porous (UniPore) copper", Materials & Design, 90, 867-880, 2016.

Thank you for your attention!

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