Microstructural evolution and Mechanical Properties of PBX composites processed by ultrasonic assisted powder compaction

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Background, Motivation, and Objective:

Pressing form is a well-established process to manufacture PBX parts of different shapes with desired mechanical properties. In compaction process, due to the friction between the PBX powder and mould, it is difficult to achieve the desired density and homogeneity of PBX parts. Improving the parts density, structural homogeneity and mechanical properties are the most challenging issues in the PBX compaction process. Many researches have been conducted to develop the PBX compaction process. However, these developed processes still have their limitations such as the large residual stress, which causes many damage and fracture defects. By applying the ultrasonic vibration, the friction effects and flow stress in forming process may decrease and the parts fabricated by powder metallurgy may result in smaller residual stress, more uniform microstructural and greater densities. This technique provides an efficient method to manufacture high-performance PBX parts at low cost.

Statement of Contribution/Methods:

The ultrasonic-assisted large-diameter PBX compaction technique and equipment was introduced and designed based on axial and radial ultrasonic vibration loading technology, which has not been found in previous literature. With the ultrasonic-assisted PBX compaction technique, the microstructural evolution and force chain distribution and mechanical behaviour of PBX parts were analyzed by various characterization techniques, such as CT, SEM, SANS (Small Angle Neutron Scattering), photo elasticity test and Brazilian test.

Results/Discussion:

It is found that the force chain distribution of PBX parts becomes more uniform and the internal voids become smaller while the diameter expansion and density differences decrease by applying the ultrasonic vibration as the vibration reduces the friction effects and forming defects, and increases the plastic forming plasticity. Further, the residual stress and particle size of PBX parts are significantly reduced. Then, the compression modulus and strength, and the tensile fracture and strength are also increased by 35% or more.

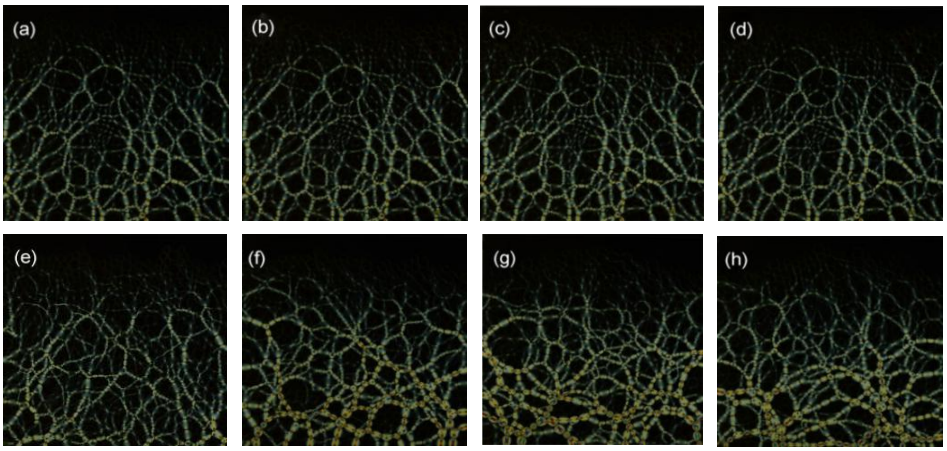

Fig.1 Force chain distribution of PBX processed by ultrasonic assisted powder compaction(a-d) and conventional static pressure forming(e-h)