THE EFFECT OF THE MICROSTRUCTURE ON THE EFFICIENCY OF SHAPED CHARGES OBTAINED VIA POWDER METALLURGY

Martyna Strąg*, Paweł Podgórzak, Jan Bagrowski, Piotr Ruliński

Military Institute of Armament Technology, Prymasa Wyszyńskiego 7, 05-220 Zielonka

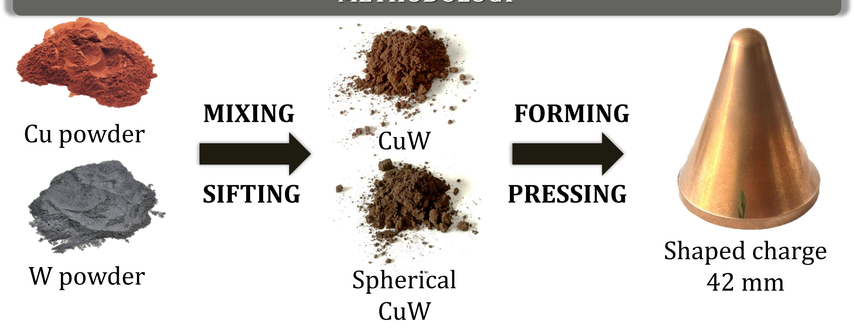
**Corresponding author: stragm@witu.mil.pl*

INTRODUCTION

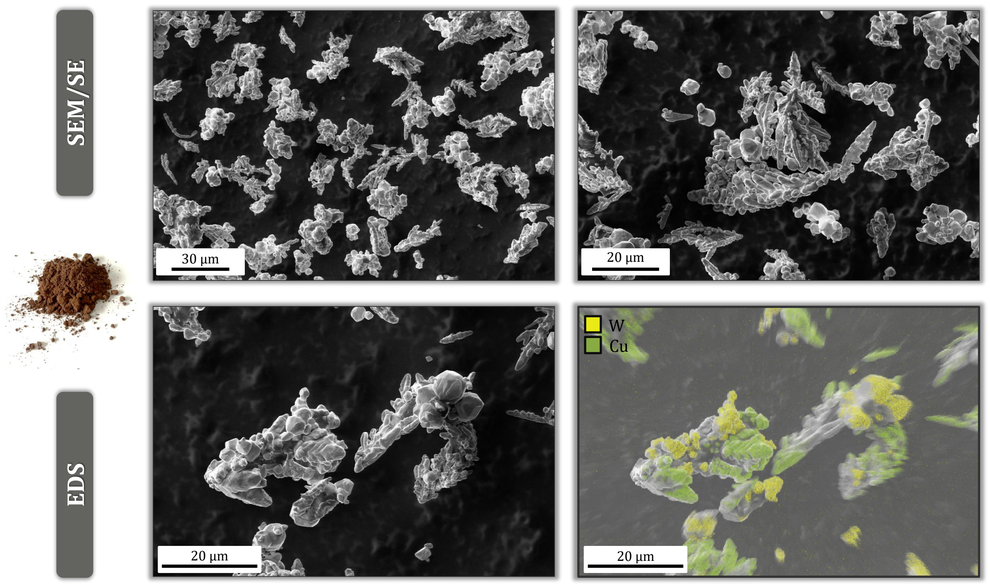
Shaped charges are used in explosive applications to direct the energy of an explosion, creating a high-velocity jet capable of penetrating materials such as steel and concrete, which makes them valuable in military contexts. These charges, typically made from copper alloys or metal powder sinters, require optimization to enhance their penetration capabilities. This study investigates the microstructure of shaped charges manufactured through powder metallurgy using tungsten and copper powders.

Scanning electron microscopy (SEM) and energy-dispersive X-ray spectroscopy (EDS) were employed to analyze grain size, elemental distribution, and composition. The results confirmed the effectiveness of the preparation procedure for shaped charges and provide a foundation for future research.

METHODOLOGY

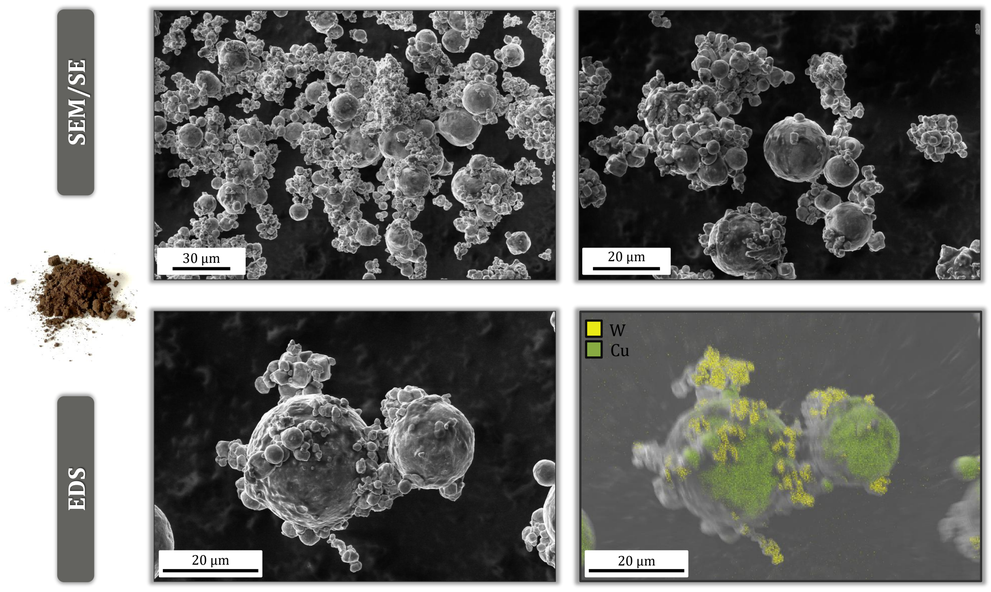


CuW



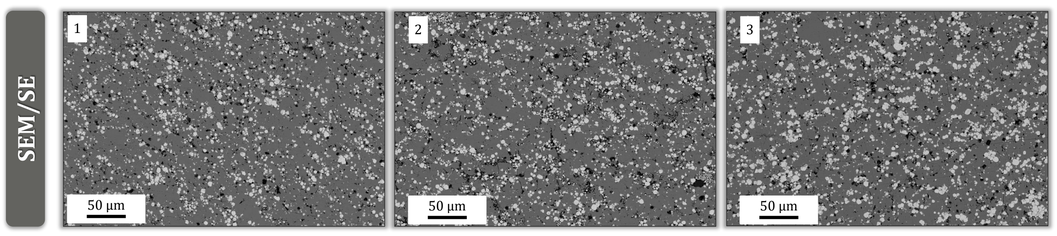
SEM/SE images *presenting the mixture of Cu and W powders and the* ***EDS map*** *showing the distribution of the elements.* The overall microstructure would show a heterogeneous distribution of copper and tungsten, with areas of concentrated tungsten particles interspersed with copper. The particles tend to form agglomerates with irregular morphology which may vary in size and shape, leading to non-uniformity in the distribution of the two metals.

CuW spherical

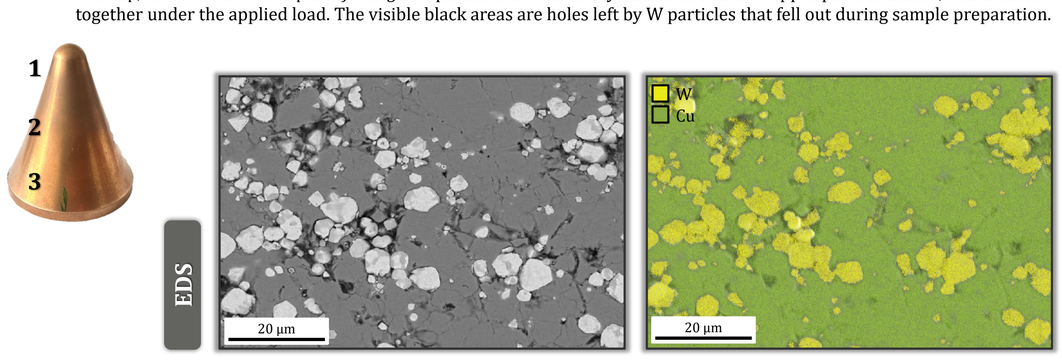


SEM/SE images *show a mixture of spherical Cu and W powders, along with an* ***EDS map*** *illustrating the distribution of elements.* The microstructure reveals large spherical Cu particles (~20 µm in size) surrounded by much finer W particles, which measure only a few microns. These W particles tend to form agglomerates that are irregularly distributed.

CuW

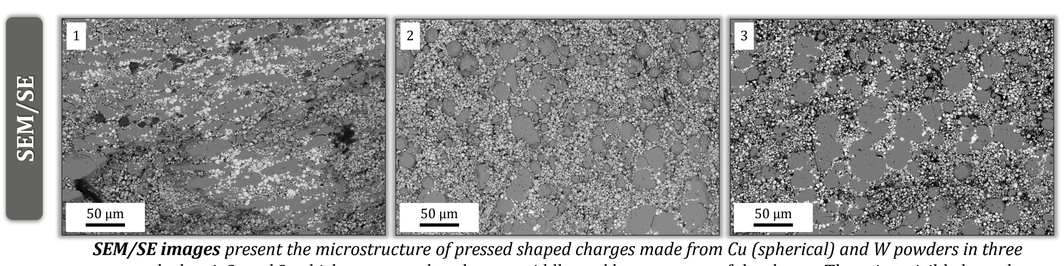


SEM/SE images *presenting the microstructure of pressed shaped charge in three areas marked as 1, 2, 3 which corresponds to the top, middle and bottom part of charge.* W particles are uniformly distributed in the copper particle matrix, which fused together under the applied load. The visible black areas are holes left by W particles that fell out during sample preparation.

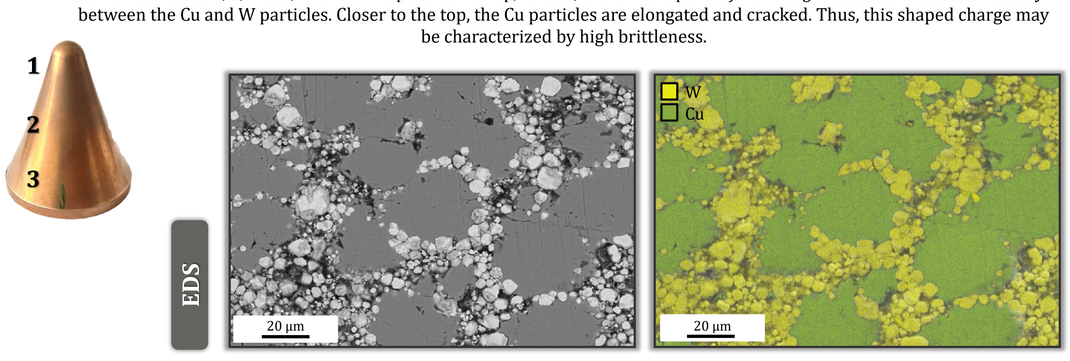


EDS map *showing the distribution of the elements in pressed shaped charge.* The W particles (collored in yellow) are embedded in soft Cu matrix (colored in green).

CuW spherical



SEM/SE images *present the microstructure of pressed shaped charges made from Cu (spherical) and W powders in three areas marked as 1, 2, and 3, which correspond to the top, middle, and bottom parts of the charge.* There is a visible boundary between the Cu and W particles. Closer to the top, the Cu particles are elongated and cracked. Thus, this shaped charge may be characterized by high brittleness.



EDS map *showing the distribution of the elements in pressed shaped charge.* The W particles (collored in yellow) are located at the Cu grain boundaries (colored in green). They form agglomerates with various thickness.

SUMMARY

The presented studies confirmed the procedure for preparing shaped charges. The results indicated that the mixture containing electrochemically obtained copper powder with a grain size of around 40 microns is more promising for use in shaped charges than the spherical powder. Future studies will focus on evaluating the effectiveness of the produced shaped charges, specifically their ability to penetrate protective armor.

WOJSKOWY INSTYTUT TECHNICZNY UZBROJENIA MILITARY INSTITUTE OF ARMAMENT TECHNOLOGY
05-220 Zielonka, ul. Prymasa Stefana Wyszyńskiego 7
tel.: (+48 22) 761 44 01 fax: (+48 22) 761 44 45 www.witu.mil.pl e-mail: witu@witu.mil.pl

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