Graded Metal Matrix Composite for Ballistics Applications Manufactured using Cold Spray Technology

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Ballistic armor systems consist of ceramic and metallic plates to absorb the energy and prevent penetration of high velocity projectiles. Advancements to armor systems can be made by improving their energy absorption characteristic, reducing their weight, adding multi-impact performance capability, and improving their ergonomics. Cold spray technology has the unique ability to manufacture a thick metal matrix composite material, while being able to control the material properties through the thickness of the material. The goal of this research is to develop and manufacture a graded composite consisting of a ductile metallic matrix and a strengthening ceramic material. Research was conducted to determine a set of spray parameters to effectively spray a wide array of ceramic powders blended with a ductile metallic material. These parameters included pressure, temperature, volume fraction of ceramic/metallic mixed powder, and the use of a chiller to cool the applicator to prevent clogging. During this early work, it was found that increasing the ratio of ceramic/metallic material did not have enough of an effect to achieve the ceramic volume fraction desired. As a result, current work has been focused on increasing the volume fraction of ceramic present in deposited materials. Parameters currently being investigated include the use of more ductile metallic materials, increasing the powder feed rate, and the use of a laser to increase the ductility of the metallic material during the spray process. The resulting plates will be tested for compression, impact resistance by using a Split Hopkinson Pressure Bar (SHPB) and drop tests to help inform the process of developing and ultimately manufacturing and testing a full thickness graded composite.