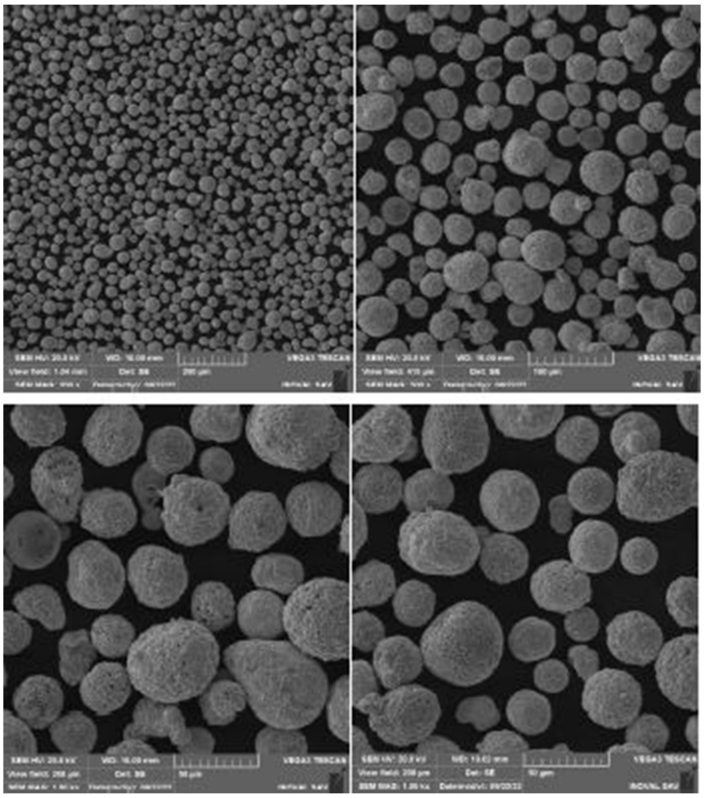
Spherodized Ceramic Materials for Additive Manufacturing



ZrO2 powder after Spheroidization

Zirconia (ZrO2) is a highly refractory ceramic material that is known for its excellent strength and toughness, as well as its good thermal stability and chemical resistance. In its spherical form, ZrO2 particles can be used to create powders and coatings with improved flowability, which can be beneficial in a variety of applications. For example, ZrO2 particles can be used as a reinforcement material in composite materials to improve the mechanical properties, or as a abrasive in grinding and polishing applications due to their hardness and durability.

Similarly, tungsten carbide cobalt (WC-12Co) is a hard and wear-resistant material that is commonly used in cutting tools and wear-resistant coatings due to its excellent hardness and resistance to abrasion. In its spherical form, WC-12Co particles can be used to create powders with improved flowability, which can be useful in applications such as spray forming and powder metallurgy. Additionally, the spherical shape of the WC-12Co particles can help to improve the mechanical properties of composite materials by reducing the porosity and increasing the density.

This means the spherical form of both ZrO_2 and WC-12Co particles can offer a range of benefits in terms of improved flowability and improved mechanical properties,

One key characteristic of ZrO_2 particles is their relatively spherical shape and smooth surface, which gives them good fluidity. This fluidity was measured using a Hall funnel with an opening of 2.5 mm, and was found to be 0.91 cm^3/s, or 3.05 g/s. Additionally, the particle sizes of the ZrO_2 particles were found to be relatively narrow, ranging from 10 to 65 µm with a mean size of approximately 39 µm.

The density of the ZrO_2 particles was also measured, with the free powder density of the supplied sample found to be approximately 3.36 g/cm^3, which is 59.2% of the theoretical density. However, it was found that the maximum density of the free ZrO_2 powder (3.71 g/cm^3) was achieved when using a bimodal powder mixture containing 80% fine fraction (particles below 32 µm) and 20% coarse fraction (particles above 32 µm) after vibrations. This value represents 65.32% of the theoretical density, and can be increased further by using a larger particle size difference between the fine and coarse powders.

On the other hand, WC-12Co particles were found to be less spherical than ZrO_2 particles, with a rough and porous surface. However, they still possess good fluidity, with a value of 0.68 cm^3/s, or 0.57 g/s, as measured using a Hall funnel with an opening of 2.5 mm. The particle sizes of WC-12Co particles were also found to be narrow, ranging from 10 to 65 µm with a mean size of approximately 48 µm.

The density of WC-12Co particles was also measured, with the free powder density of the supplied sample found to be approximately 6.72 g/cm^3, which is 45.0% of the theoretical density. The maximum density of the free WC-12Co powder was achieved through vibration of the loose mixture, reaching a value of 7.55 g/cm^3, or 51% of the theoretical density. It was found that using a combination of fine (below 32 µm) and coarse (above 32 µm) fractions did not result in any density benefit when compared to the original sample. Again, it was found that the higher density value can be achieved by using a larger particle size difference between the fine and coarse powders.

Overall, these findings highlight the unique characteristics of ZrO_2 and WC-12Co particles, and suggest potential avenues for further research in this area. For example, further investigation into the effect of particle size and shape on the fluidity and density of these materials may lead to new insights and applications.