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Precision Universal Testing Machine AGX™-V2

Application News

# Measuring the Bulk Density of Graphite Powder

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## User Benefits

- Bulk density, an important property of battery materials for improving battery performance can be measured.
- By using a precision universal testing machine, bulk density can be evaluated over a wide load range, from low to high.

## ■ Introduction

The lithium-ion battery (LiB) market is expected to expand further in the future as countries around the world promote the transition to electric vehicles with the aim of carbon neutrality and as demand for smartphones, tablet devices, etc. increases.

The coating technology for current collectors greatly affects the characteristics of batteries in the LiB manufacturing process. When manufacturing LiB electrodes, active materials are mixed with a binder and solvent, applied to a current collector, dried, and then pressed to increase packing density. It is believed that the thickness and mass of electrodes affect the energy density of LiBs, with thicker coatings resulting in larger battery capacities and lower rate characteristics. Conversely, thinner coatings result in better rate characteristics but smaller battery capacities. To improve the volumetric energy density of LiBs, it is important to improve the filling properties of the positive and negative electrode active materials and increase the density of the electrodes.

Therefore, evaluation of the density of positive and negative electrode materials is important for improving the characteristics of batteries and achieving the desired battery performance. To satisfy the pressure conditions of the manufacturing process, the measurements need to cover the density changes of powder samples continuously from low to high pressures. This article introduces an example of evaluating the bulk density of graphite powder that is used as an anode material using the AGX-V2 precision universal testing machine.

## ■ Test Configuration

Table 1 shows the condition of the test, which was conducted using the AGX-V2 precision universal testing machine with a powder-forming test device attached. In powder compression testing, the test force is dispersed to the wall inside the die. To cope with this, the test force is measured at the top and bottom. The applied force is calculated from the average of the test force of the upper and lower load cells. Even if the mass of the powder and the load test force are the same, the dispersion pressure on the wall surface will change, depending on the die diameter, which may lead to different test results. These tests were conducted with samples of 1 g weight, using a 1/2 inch diameter molding die and applying a force of up to 50 kN to the upper load cell.

Table 1 Test Configuration and Test Conditions Using the Precision Universal Testing Machine

| | |
|---|---|
| Testing Machine: | AGX-100kNV2 |
| Upper Load Cell: | 100 kN |
| Lower Load Cell: | 100 kN |
| Test Jig: | Powder forming test device (molding die diameter 1/2 inch) |
| Software: | TRAPEZIUMX™-V (single) |
| Test Speed: | 5 mm/min |
| Target Value: | Up to a test force of 50 kN in the upper load cell |
| Sample: | Four types of graphite powder (A, B, C, and D) with different particle sizes |
| Sample Mass: | Weighed to 1 g ± 0.005 g |

Fig. 2 shows a view of the test. Using the deflection correction function of the TRAPEZIUMX-V, measurements were performed by deducting the deformation of the jig and the load cell from the crosshead movement amount.


Fig. 1 Precision Universal Testing Machine AGX™-V2

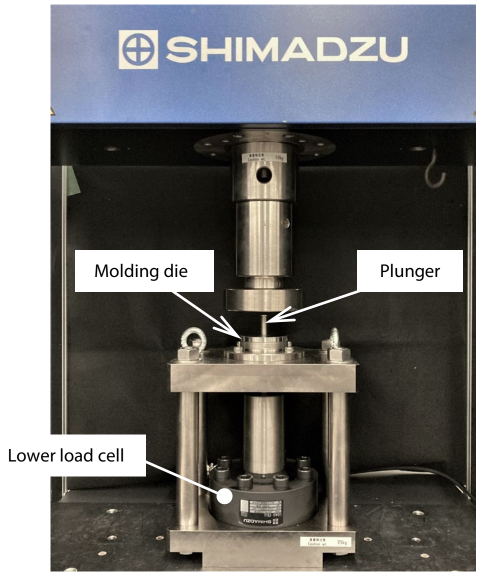


Fig. 2 View of a Test

## ■ Test Results

Fig. 3 shows the test results. It was found that for all samples, the bulk density approached approximately 2.3 g/cm$^3$ when the average stress of the upper and lower load cells was approximately 350 MPa. Fig. 4 shows the curves for the average stress up to 1 MPa. Samples B, C, and D behave similarly, but sample A behaves differently. Fig. 5 shows the curves for the average stress up to 50 MPa. Comparing the bulk densities under a load of 50 MPa, it can be seen that the bulk densities decrease in the order of A = D > C > B.

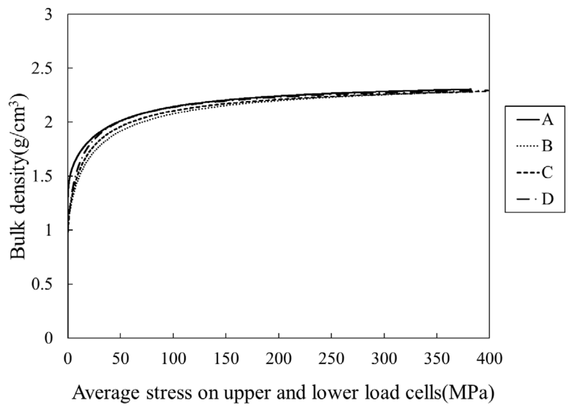


Fig. 3 Test Results

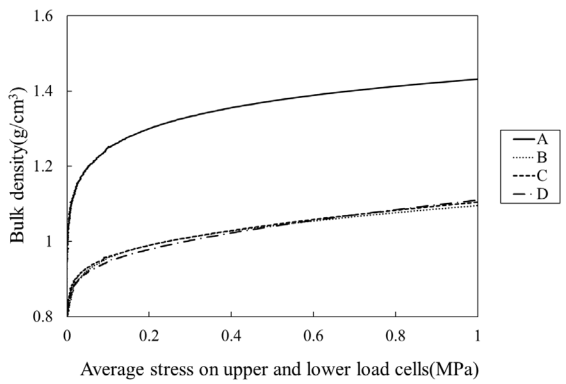


Fig. 4 Test Results (Curves up to 1 MPa)

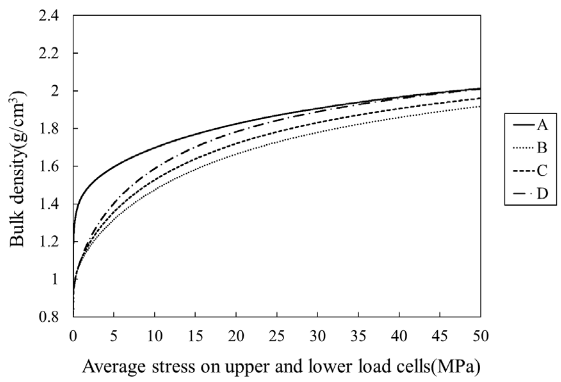


Fig. 5 Test Results (Curves up to 50 MPa)

## ■ Conclusion

Using the AGX-100kNV2, bulk density was measured for four types of graphite powders with different particle sizes. It was found that each sample behaved differently depending on the amount of test force applied. However, with high test forces, the behavior of all samples was similar, and all had bulk densities of approximately 2.3 g/cm$^3$.

By using the AGX-V2, bulk density can be measured with a wide range of forces, from low to high. Measuring bulk density is expected to contribute to achieving the desired battery performance, such as improving energy density.

Acknowledgments

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