INTISARI

Peningkatan penggunaan kendaraan listrik menyebabkan kebutuhan terhadap baterai *lithium-ion* semakin tinggi, khususnya tipe 18650 dengan komposisi NMC (*Nickel Manganese Cobalt*). Namun, meningkatnya jumlah baterai bekas menimbulkan permasalahan lingkungan akibat kandungan logam berat dan elektrolit beracun. Oleh karena itu, diperlukan proses daur ulang yang efektif untuk memulihkan material berharga sekaligus mengurangi dampak limbah. Penelitian ini bertujuan untuk mempelajari proses *pre-treatment* daur ulang baterai *lithium-ion* 18650 melalui kombinasi perlakuan panas (*heat treatment*) dan proses mekanik, serta mengevaluasi sifat mekanik cangkang baterai setelah pemanasan.

Metode penelitian diawali dengan proses pemanasan baterai utuh pada suhu 480°C menggunakan sistem pemanasan untuk menguraikan elektrolit dan binder. Tahapan selanjutnya meliputi pemisahan komponen, penghancuran, perontokan, dan pengayakan untuk memperoleh *black mass* yang homogen. Pengujian mekanik pada cangkang baterai meliputi uji tarik dan uji kekerasan *Vickers* guna mengetahui perubahan sifat mekanik pasca perlakuan panas.

Hasil penelitian menunjukkan bahwa perlakuan panas mampu menghilangkan residu organik, mempermudah proses mekanik, serta menghasilkan *black mass* dengan distribusi partikel lebih halus. Nilai *ultimate tensile strength* cangkang baterai berada pada kisaran 545–652 MPa, dengan kekerasan antara 119–516 HV. Penurunan kekuatan dan kekerasan menunjukkan terjadinya perubahan mikrostruktur akibat suhu tinggi. Secara keseluruhan, kombinasi proses *heat treatment* dan mekanik terbukti efektif sebagai tahap *pre-treatment* dalam daur ulang baterai lithium-ion 18650.

Kata kunci: Baterai *Lithium-ion* 18650, Proses Pemanasan Baterai, Daur Ulang Mekanik, *Black Mass*, Uji Mekanik

ABSTRACT

The increasing use of electric vehicles has led to a growing demand for lithium-ion batteries, particularly the 18650 type with NMC (Nickel Manganese Cobalt) composition. However, the rise in spent batteries poses environmental concerns due to the presence of heavy metals and toxic electrolytes. Therefore, an effective recycling process is needed to recover valuable materials while minimizing waste impact. This study aims to investigate the pre-treatment process of lithium-ion battery recycling through a combination of heat treatment and mechanical methods, as well as to evaluate the mechanical properties of the battery shell after heating.

The research method begins with heating intact batteries at 480°C using a heating system to remove electrolytes and binders. Subsequent steps include dismantling, crushing, ball milling, and sieving to obtain a homogeneous black mass. Mechanical testing of the battery shell, including tensile and Vickers hardness tests, was conducted to determine the mechanical property changes after heat treatment.

The results show that heat treatment successfully removed organic residues, facilitated mechanical processing, and produced black mass with finer particle distribution. The ultimate tensile strength of the shell ranged from 545 to 652 MPa, with hardness values between 119 and 516 HV. The decrease in strength and hardness indicates microstructural changes due to high-temperature exposure. Overall, the combination of heat treatment and mechanical processes proved effective as a pre-treatment stage for recycling 18650 lithium-ion batteries.

***Keywords*:** *18650 Lithium-ion Battery, Battery Heat Treatment, Mechanical Recycling, Black Mass, Mechanical Testing*