INTISARI

Perkembangan perangkat *wearable* mendorong berkembangnya *flexible sensor* yang dapat difabrikasi dengan geometri yang kompleks. Penelitian ini bertujuan untuk mengevaluasi dan membandingkan kinerja sensor komposit berbasis matriks Termoplastik Poliuretan (TPU) dengan *filler* Multi-Walled Carbon Nanotubes (MWCNT) dengan konsentrasi 1-5 wt.% yang difabrikasi dengan dua metode: *solution casting* dan 3D *print.* Pengujian yang dilakukan meliputi uji resistivitas listrik, uji tarik, *hardness,* dan uji pembebanan siklik untuk mendapatkan karakter histeresis. Hasil penelitian menunjukkan *percolation threshold* dari *solution casting* tercapai pada konsentrasi 3 wt.%, tetapi *percolation threshold* dari tiga dimensi (3D) *print* baru tercapai pada 4 wt.%. Secara mekanik, metode *solution casting* memiliki karakteristik yang lebih unggul, ditandai dengan nilai *secant modulus, hardness,* kekuatan tarik, *elongation at break,* dan ketangguhan yang lebih tinggi dibandingkan metode 3D *print.* Spesimen 3D *print* mengalami penurunan kekuatan mekanik akibat adanya *void* dan lemahnya ikatan antar *layer.* Namun, ditinjau dari analisis performa dinamis, metode 3D *print* menghasilkan material dengan Derajat Histeresis (DH) dan Energi Histeresis (EH) yang lebih rendah dibandingkan metode *casting.* Hal ini mengindikasikan sensor yang difabrikasi menggunakan 3D *print* memiliki respon sinyal yang lebih akurat dan stabil. Berdasarkan analisis matriks pembobotan, variasi 5 wt.% 3D *print* merupakan variasi yang paling optimal ditinjau dari beberapa aspek terkait implementasi sebagai sensor yakni keandalan, kenyamanan, dan *durability*. Selain itu, terpilihnya variasi 5 wt.% juga menunjukkan kelayakan metode *Fused Deposition Modeling* (FDM) 3D *print* sebagai metode fabrikasi *flexible sensor.*

Kata kunci: *Flexible sensor,* TPU/CNT, FDM 3D *print, solution casting,* histeresis, piezoresistif

ABSTRACT

The development of wearable devices has driven the development of flexible sensors that can be fabricated with complex geometries. This study aims to evaluate and compare the performance of composite sensors based on a thermoplastic polyurethane (TPU) matrix with multi-walled carbon nanotubes (MWCNT) fillers at concentrations of 1-5 wt.% fabricated using two methods: solution casting and 3D printing. The tests conducted included electrical resistivity, tensile, hardness, and cyclic loading tests to obtain hysteresis characteristics. The results showed that the percolation threshold of solution casting was achieved at a concentration of 3 wt.%, but the percolation threshold of 3D printing was only achieved at 4 wt.%. Mechanically, the solution casting method exhibits superior characteristics, characterized by a higher secant modulus, hardness, tensile strength, elongation at break, and toughness compared to the 3D printing method. The 3D-printed specimens experienced a decrease in mechanical strength due to the presence of voids and weak interlayer bonding. However, when viewed from a dynamic performance analysis, the 3D printing method produced materials with a lower degree of hysteresis (DH) and energy of hysteresis (EH) compared to the casting method. This indicates that sensors fabricated using 3D printing have a more accurate and stable signal response. Based on the weighting matrix analysis, the 5 wt.% 3D print variation is the most optimal variation in terms of several aspects related to its implementation as a sensor, namely reliability, comfort, and durability. In addition, the selection of the 5 wt.% variation also demonstrates the feasibility of the FDM 3D printing method as a flexible sensor fabrication method.

Keywords: Flexible sensor, TPU/CNT, FDM 3D print, solution casting, hysteresis, piezoresistive