

*Fused deposition modelling* (FDM) saat ini menjadi teknik *3D printing* yang populer untuk material polimer. Teknik ini menggunakan filamen polimer yang dilebur dan dideposisikan lapis demi lapis sehingga menjadi objek 3-dimensi. Meski demikian, jenis polimer yang bisa digunakan sebagai bahan baku proses FDM ini masih terbatas. Sebagai contoh, belum ada filamen dari bahan *ultra-high molecular weight polyethylene* (UHMWPE) yang tersedia di pasar. Oleh karenanya, studi awal untuk membuat filamen UHMWPE perlu dilakukan.

Dalam penelitian ini, pengaruh temperatur proses ekstrusi, konsentrasi penambahan *polyethylene glycol* (PEG) dan kecepatan putar *screw* terhadap sifat fisis, kimiawi dan mekanis filamen UHMWPE dipelajari melalui serangkaian eksperimen. Proses ekstrusi filamen UHMWPE dilakukan dengan menambahkan PEG dan *paraffin oil* (PO) untuk meningkatkan sifat mampu-proses material UHMWPE. Temperatur proses divariasikan dari 160 hingga 180 °C, penambahan PEG divariasikan dari 10 hingga 30 wt% dan kecepatan putar *screw* divariasikan menjadi 11 dan 14 rpm.

Hasil pengamatan dengan mikroskop elektron menunjukkan proses ekstrusi jenis polimer ini berlangsung dengan stabil. Karakterisasi dengan *differential scanning calorimetry* menunjukkan terjadi penurunan derajat kristalinitas filamen seiring dengan (1) penurunan temperatur ekstrusi, (2) peningkatan konsentrasi PEG dan (3) penurunan kecepatan putar *screw*. Hasil karakterisasi dengan *Fourier Transform Infrared Spectroscopy* menunjukkan tidak adanya perubahan komposisi kimia pada filamen. Berdasarkan analisa statistik disimpulkan bahwa parameter ekstrusi filamen yang optimal berdasarkan tingkat pengaruhnya adalah (1) penambahan 10wt% PEG, (2) temperatur ekstrusi 180 °C dan (3) kecepatan putar *screw* 11 rpm. Hasil pengujian mekanis menunjukkan bahwa kekuatan tarik filamen lebih rendah dibandingkan *rod* UHMWPE murni. Kekuatan tarik filamen UHMWPE tertinggi yang dihasilkan pada penelitian ini mencapai 23,49 MPa.

**Kata Kunci:** UHMWPE, ekstrusi, filamen, *3D printing*, temperatur

**ABSTRACT**

*Currently, fused deposition modeling (FDM) has become a popular 3D printing technique for the fabrication of polymeric parts. In this technique, a polymer filament is melted and deposited layer-by-layer to form 3-dimensional objects. However, there are still limited number of polymer types that has been successfully used as a raw material for the FDM process. Up to now, for instance, there is still no filament made of ultra-high molecular weight polyethylene (UHMWPE) available in the market. Therefore, a preliminary study concerning the fabrication of such UHMWPE filament needs to be conducted.*

*In this study, the influence of extrusion temperature, polyethylene glycol (PEG) concentration, and speed of screw rotation used in the fabrication of UHMWPE filament on the physical, chemical, and mechanical properties of such filament was studied. The extrusion process was carried out by adding PEG and paraffin oil (PO) to improve the processability of UHMWPE material and with temperatures varying from 160 to 180 °C, PEG additions varying from 10 to 30 wt%, and the screw rotation speeds varying from 11 to 14 rpm.*

*The result of examination by using electron microscope revealed that extrusion process of this polymer was running stable. The characterization by using differential scanning calorimetry (DSC) showed a decrease in the degree of filament crystallinity with (1) the decrease of extrusion temperature, (2) the increase of PEG concentration and (3) the decrease of screw rotating speed. The characterization by using Fourier Transform Infrared Spectroscopy (FTIR) indicated no change in chemical compositions over the filament product with these conditions applied. Based on statistical analysis, it was concluded that the optimal filament extrusion parameters based on the level of influence are (1) 10wt% PEG addition, (2) 180 °C extrusion temperature, and (3) 11 rpm screw rotating speed. The mechanical test results show that the tensile strength of the filament is lower than pure UHMWPE rods. The highest tensile strength of UHMWPE filaments produced in this study reached 23.49 MPa.*

**Keywords:** UHMWPE, extrusion, filament, 3D printing, temperature