Perubahan Sifat Shape Memory Effect (SME) dan Bioaktivitas Scaffold Poly-Lactic Acid (PLA) Produk 3D Print akibat Variasi Konsentrasi Hidroksiapatit sebagai Modifikator Permukaan = Changes in Shape Memory Effect (SME) Properties and Bioactivity of 3D Printed Poly-Lactic Acid (PLA) Scaffolds due to Varying Hydroxyapatite Concentration as Surface Modifiers

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Abstrak

Perkembangan teknologi 3D print telah merevolusi bidang rekayasa jaringan dalam manufaktur scaffold dengan struktur yang kompleks. Penggunaan poly-lactic acid (PLA) sebagai bahan dasar scaffold telah umum digunakan karena sifatnya yang biokompatibel dan bioresorbable. Di sisi lain, PLA memiliki sifat unik berupa shape memory effect (SME) sehingga membuka peluang dalam pengembangan self-fitting scaffold. Namun, permukaan PLA yang bersifat hidrofobik menghambat interaksi scaffold dengan jaringan sekitar. Sebagai upaya untuk meningkatkan hidrofilisitas permukaan, scaffold PLA dilakukan modifikasi permukaan menggunakan alkali treatment dan pelapisan hidroksiapatit (HAp). Hidroksiapatit merupakan utama penyusun tulang sehingga diharapkan mampu meningkatkan fungsi biologis scaffold. Untuk mengetahui konsentrasi pelapisan HAp yang optimal dilakukan variasi konsentrasi HAp dalam dispersi HAp-etanol sebesar 0,5, 1, dan 2% (w/v). Pengaruhnya terhadap SME dan bioaktivitas scaffold PLA akan dievaluasi menggunakan uji imersi r-SBF, observasi visual, uji kompresi, dan karakterisasi SEM-EDS. Hasil uji imersi menunjukkan bahwa pemberian dan peningkatan konsentrasi HAp pada permukaan mampu meningkatkan kemampuan absorpsi air scaffold secara signifikan. Selain itu, scaffold juga terukur mengalami tren peningkatan massa selama pengujian. Observasi visual menunjukkan adanya kristal putih terpresipitasi. Melalui karakterisasi SEM-EDS diketahui komposisi kristal yang terbentuk adalah CaP. Dengan demikian, dapat diketahui bahwa peningkatan konsentrasi lapisan HAp akan meningkatkan bioaktivitas scaffold melalui peningkatan laju presipitasi CaP. Namun, hal ini juga akan berdampak pada penurunan kekuatan kompresi serta kemampuan strain recovery akibat adanya penetrasi HAp ke dalam scaffold sehingga mengalami aglomerasi dan menyebabkan terjadinya embrittlement pada scaffold.
......The development of 3D printing technology has revolutionized the field of tissue engineering in manufacturing scaffolds with complex structures. The use of poly-lactic acid (PLA) as the base material for scaffolds has been widely adopted due to its biocompatible and bioresorbable properties. However, PLA has a unique property known as shape memory effect (SME), which opens up opportunities for the development of self-fitting scaffolds. On the other hand, the hydrophobic nature of PLA surfaces inhibits the interaction between the scaffold and the surrounding tissue. In an effort to enhance the hydrophilicity of the surface, surface modifications are performed on PLA scaffolds using alkali treatment and hydroxyapatite (HAp) coating. Hydroxyapatite, being the main component of bone, is expected to improve the biological function of the scaffold. To determine the optimal concentration of HAp coating, variations in HAp concentration in the HAp-ethanol dispersion are conducted at 0.5%, 1%, and 2% (w/v). Their influence on the SME and bioactivity of the PLA scaffold will be evaluated using r-SBF immersion tests, visual observations, compression tests, and SEM-EDS characterization. The immersion test results show that the addition and

increased concentration of HAp on the surface significantly enhance the water absorption capacity of the scaffold. Additionally, the scaffold's measured mass shows an increasing trend during the testing. Visual observations reveal the presence of white crystals that precipitate. Through SEM-EDS characterization, it is determined that the composition of the formed crystals is CaP. Thus, it can be concluded that increasing the concentration of the HAp layer enhances the scaffold's bioactivity by increasing the rate of CaP precipitation. However, this also leads to a decrease in compressive strength and strain recovery ability due to HAp penetration into the scaffold, causing agglomeration and resulting in scaffold embrittlement.