Pengaruh unsur paduan Sn terhadap sifat korosi paduan TiNb = Effect of Sn element on corrosion behaviour of TiNb alloys

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Abstrak

Tantangan dalam pengembangan implant permanen tulang dan gigi berbasis titanium (Ti) adalah meminimalisir unsur paduan yang bersifat toxic. Paduan yang saat ini paling banyak digunakan secara klinis adalah Ti-6Al-4V. Unsur Al and V bersifat toxic dan berpotensi menimbulkan reaksi alergi. Untuk mengatasi masalah tersebut, dikembangkan paduan metastabil Î²-Ti yang memiliki sifat non-alergi, modulus elastisitas rendah, dan ketahanan korosi yang baik. Dalam penelitian ini, paduan metastabil TiNbSn difabrikasi dengan metode arc melting dengan variasi konsentrasi Sn 2, 5 dan 8 wt%. Remelting dilakukan sebanyak 5x untuk mendistribusikan unsur dalam paduan secara merata. Selanjutnya paduan diberi perlakuan solution treatment pada suhu 1000°C selama 6 jam. Pengaruh konsentrasi Sn terhadap mikrostruktur, sifat mekanik, dan sifat korosi diteliti masing-masing menggunakan mikroskop elektron, uji hardness dan modulus, dan uji elektrokimia. Analisis XRD menunjukkan bahwa paduan TiNb memiliki dua fasa yaitu Î² dan Î±. Fasa Î± berkurang dengan penambahan konsentrasi Sn dalam paduan. Selain itu, ukuran butir logam paduan TiNb dengan rata-rata 256 µm membesar seiring dengan kenaikan konsentrasi Sn dalam paduan menjadi 446, 379, dan 384 µm. Berkurangnya fasa Î± dan perbesaran ukuran butir menyebabkan turunnya nilai kekerasan dan modulus elastisitas paduan. Paduan TiNb memiliki kekerasan 292,6 HV yang kemudian turun menjadi 254,8; 267,0; 266,6 HV dengan penambahan Sn masing-masing 2, 5 dan 8 wt%. Nilai modulus elastisitasn TiNb sebesar 121.4 GPa turun drastic menjadi 95.4; 108.2; dan 103.8 GPa pada paduan yang mengandung Sn 2, 5, dan 8 wt%. Uji potensial korosi bebas, open circuit potential (OCP), menunjukkan penurunan nilai OCP dengan bertambahnya konsentrasi Sn dalam paduan. Uji polarisasi potensiodinamik menunjukkan penurunan drastis nilai potensial korosi TiNb dari -0,28 VAg/AgCl menjadi -0,52 dan -0,44 VAg/AgCl dengan penambahan 2 dan 8 wt% Sn dalam paduan. Namun, penambahan 5 wt% Sn relatif tidak merubah nilai potensial korosi paduan TiNb. Hal yang sama diperoleh pada uji electrochemical impedance spectroscopy (EIS) yang menunjukkan nilai kurva impedansi yang sama antara TiNb dan TiNb-5Sn dibandingkan dengan TiNb-2Sn dan TiNb-8Sn yang menunjukkan penurunan impendansi secara signifikan.
<hr><i>The challenge in developing titanium-based (Ti) permanent bone and tooth implants is to minimize toxic elements of the alloy. The alloy that is currently most widely used clinically is Ti-6Al-4V. Al and V elements are toxic and have the potential to cause allergic reactions. To overcome this problem, metastable Î²-Ti alloys were developed which have non-allergic properties, low elastic modulus, and good corrosion resistance. In this study, TiNbSn metastable alloys were fabricated using the arc melting method with variations in Sn 2, 5 and 8 wt% concentrations. Remelting is done as much as 5 times to distribute the elements in the alloy evenly. Furthermore, the alloy was solution treated at a temperature of 1000 ° C for 6 hours. The effect of Sn concentrations on microstructure, mechanical properties, and corrosion properties were studied using electron microscopy, hardness and modulus tests, and electrochemical tests respectively. XRD analysis shows that TiNb alloys have two phases namely Î and Î±. The Î± phase decreases with the

addition of the Sn concentration in the alloy. In addition, the grain size of TiNb alloy metal with an average of 256 µm enlarged along with the increase in Sn in alloy concentration to 446, 379, and 384 µm. Reduced Î± phase and enlargement of grain size caused a decrease in hardness value and elastic modulus of alloy. TiNb alloy has a hardness of 292.6 HV which then drops to 254.8; 267.0; 266.6 HV with the addition of Sn each of 2, 5 and 8 wt%. The elastic modulus of TiNb was 121.4 GPa which dropped dramatically to 95.4; 108.2; and 103.8 GPa on alloys containing Sn 2, 5 and 8 wt%. Free corrosion potential test, open circuit potential (OCP), shows a decrease in OCP value with increasing concentration of Sn in alloy. Potentiodynamic polarization test showed a drastic decrease in the value of TiNb corrosion potential from -0.28 VAg / AgCl to -0.52 and -0.44 VAg / AgCl with the addition of 2 and 8 wt% Sn in the alloy. However, the addition of 5 wt% Sn relative did not change the value of the TiNb alloy corrosion potential. The same was obtained from the electrochemical impedance spectroscopy (EIS) test which showed the same impedance curve value between TiNb and TiNb-5Sn compared to TiNb-2Sn and TiNb-8Sn which showed a significant decrease in impedance. </i>