A Novel Biomedical β-type Ti alloy TLM materials Used in Teeth Implants

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Statement of Purpose: Biomedical metal materials which possess high strength, high toughness and excellent workability etc. compared with the other biomaterials were first applied in hard tissues such as substituting the hard tissue like artificial bones, hip joints and dental implants and soft tissues such as stents and heart valves etc. At present, the biomedical metal materials mainly consist of stainless steel, Cobalt-based alloy and titanium alloy, and also include some rare, noble metals. Although medical stainless steel such as 316L and Co-Cr alloy had been used earlier as orthopedic implant materials, due to the toxicity of Ni, Co, Cr, higher modulus of elasticity and worse corrosion resistance, so their surgical applications are diminishing. Au, Pt, Ta, Hf possess better corrosion resistance, but are too expensive. Ti and its alloys have been excellent biomaterials suitable for substituting and repairing the soft and hard tissue because of their high ratio of strength vs. density, lower modulus of elasticity, fine corrosion resistance and workability. Although Ti64, 316L, CoCr etc. have been used in producing the parts of the above-mentioned devices, but their bio-mechanical compatibility in long-term service, etc. need improving which is necessary to develop novel Ti alloy materials.

Methods: The Ti3Zr2Sn3Mo25Nb (TLM) ingot was forged above β-transus zone, then extruded, rolled, drawn, heat treatment respectively, the rods, wires etc. with different dimension were gotten. Then the materials were prepared by cold-rolled and drawn separately. The samples cut from the above-mentioned materials were subjected to a variety of heat treatment. The mechanical properties, OM, XRD and SEM were performed using standard techniques and methods. The biocompatibility evaluation was also assessed.

Table 1. Effect of process on mechanical properties of hot-wrought materials of TLM alloy

Dimension /mm	process mode	deforming rate/%	Rm/MPa	Rp /MPa	A5/%	E/GPa	Rp//% E	Rp/Rm/%	Heat treatment
ϕ90	β-rolled	80	970	935	12.5	81.0	0.96	96.4	STA
ϕ35	β-rolled	80	950	840	16.0	78.9	1.06	88.4	STA
ϕ15	β-rolled	80	783	598	18.0	64.0	0.93	76.3	hot-rolled
ϕ15	β-rolled	80	945	755	17.0	69.0	1.09	79.9	STA
ϕ15	α+β-rolled	80	993	910	13.0	72.0	1.26	91.6	hot-rolled
ϕ8	α+β-rolled	35	845	395	20.0	64.5	0.61	46.7	hot- drawn
ϕ8	α+β-drawn	35	925	875	14.0	73.5	1.19	94.6	STA
ϕ4	α+β-rolled	35	780	325	18.0	68.0	0.48	41.7	hot-drawn
ϕ2	α+β-rolled	35	900	385	-	-	-	42.8	hot-drawn
ϕ1	α+β-rolled	35	935	345	-	-	-	36.9	hot-drawn

Results: The results are shown that TLM alloy possess lower modulus of elasticity, moderate strength and higher plasticity under ST treated which is helpful to produce rods, wires etc. The aging treatment at low temperature leads to higher strength, adequate toughness and plasticity etc.

Conclusions: By control of the process, heat treatment and microstructure can achieve appropriate matching of comprehensive properties. It is also found the TLM alloys have excellent corrosion resistance, better biocompatibility in vitro test which is suitable for teeth implants materials.

References

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