

牙科用鑄造鈦鈮鐵合金之研削性及切削性研究

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摘要

本研究中，進行探討一系列三元Ti-5Nb-xFe(X=1、2、3、4及5 wt %)合金之微結構、機械性質、研削性及切削性，並以商業用純鈦(Grade II)及Ti-6Al-4V作為對照組，期望能開發出適合作為牙科應用之鈦合金。實驗結果顯示，Ti-5Nb合金為 α 相繞射峰，添加Fe元素也開始觀察出體心立方(bcc)結構之 β 相，隨著Fe元素含量增加到4wt%或更高時， β 相完全消失只觀察到從高溫被殘留下的 β 相。由低掃描速度(0.5 deg/min)並觀察出Ti-5Nb-5Fe合金有微量 β 相的出現，Ti-5Nb-4Fe合金則有大量的 β 相。在微硬度方面，Ti-5Nb-4Fe合金因有 β 相使得微硬度也是一系列Ti-5Nb-xFe合金中最高的，並且在研削性測試結果發現，微硬度與研削量有相似的趨勢。評估研削性為金屬每分鐘的移除量(研削量)及金屬被研削之切屑體積與砂輪直徑被磨削之體積的比(研削比)，而每個金屬之研削性都依賴著這些條件。當Fe元素添加入合金發現，在Fe元素含量較高時，使其更加容易加工，有助於改善研削性質。在1000 m/min 研削速率下，Ti-5Nb-4Fe合金之研削速率是c.p. Ti的1.9倍。切削性的評估為切削力，由刀具從試片邊緣切削進給，計算不同合金之平均切削力。實驗結果顯示，以目前的切削條件下，Ti-5Nb-xFe合金與c.p. Ti相比，當Fe元素含量遞增時，使其切削力有大幅提升的趨勢至Ti-5Nb-4Fe時下降。在Fe元素含量較高時，展現出更加容易之加工特性。Ti-5Nb-4Fe合金於110 m/min 切削轉速下，進給速度為30 mm/min時，切削力為5.09N；此外，添加切削液後會使Ti-5Nb-xFe合金之切削力下降1~4N。而Ti-5Nb-4Fe合金於110 m/min 切削轉速下之試片凹槽表面，顯示出沒有金屬切屑的黏附，且擁有最低的表面粗糙值(Ra)。

關鍵詞：牙科合金、鈦合金、微結構、研削性、切削性、機械性質

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