Revisiting Low-Modulus Titanium Alloy for Biomedical Applications by Artificial Neural Network and In-Situ Syncrotron Experiment

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Abstract

A neural-network machine called "βLow" enables a high-throughput recommendation for new β titanium alloys with Young's moduli lower than 50 GPa [1]. The machine was trained by using a very general approach with small data from experiments. Its efficiency and accuracy break the barrier for alloy discovery. βLow's best recommendation, Ti-12Nb-12Zr-12Sn (in wt.%) alloy, was unexpected in previous methods. This new alloy meets the requirements for bio-compatibility, low modulus, and low cost, and holds promise for orthopedic and prosthetic implants. In this talk, we would revisit the origin of low modulus of Ti alloy by artificial neural network and in-situ synchrotron diffraction. It is proposed that abnormal low Youngs modulus exists in β titanium when it situates the vicinity between metastable and unstable [2]. Moreover, we will further discuss future research plan in this field by the combination of machine learning and in-situ synchrotron diffraction.

Keywords – Artificial Neural Network; In-situ Synchrotron Diffraction, β titanium, Youngs Modulus

References

[1] C.T. Wu et al., "Machine learning recommends affordable new Ti alloy with bone-like modulus," *Materials Today*, vol. 34, pp. 41-50, April 2020.
[2] C.T. Wu et al, "Revisit Low-Modulus Titanium Alloy by Artificial Neural Network,", *Journal of Alloys and Compounds*, Submitted.