

反应堆工程

# 锆合金薄壁细管的单调拉伸与低周疲劳试验研究

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**摘要** 利用自行研制的高温夹具完成了Zr-1Nb合金和Zr-4合金薄壁短管试样不同温度下的单调拉伸和375 °C下的等幅低周疲劳试验, 获得了两种锆合金的单调和循环本构关系及Manson-Coffin寿命估算模型。研究结果表明: Zr-1Nb合金和Zr-4合金的弹性模量、屈服强度、抗拉强度以及应变硬化程度明显下降。随着温度的升高, 温度对Zr-4合金的应变硬化程度的影响逐渐减弱; 应变速率对Zr-4合金的拉伸性能的影响微弱。在等幅应变循环过程中, Zr-4合金表现为循环硬化, 应变幅越低, 硬化现象越明显; Zr-1Nb在较低应变幅下表现为循环硬化特性, 而在较高应变幅下表现为循环软化。相对于单调拉伸行为, Zr-4合金在不同温度下的循环行为均表现出明显的强化特性。

**关键词** [Zr-1Nb合金](#) [Zr-4合金](#) [低周疲劳](#) [薄壁管](#) [寿命估算](#)

分类号

## Uniaxial Tension and Low Cycle Fatigue Behavior of Thin-Walled Tubes for Zr-1Nb and Zr-4

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**Abstract** By using a set of self-invented clamps and thin-walled tubular specimens with small diameter, a series of monotonic tension tests at different temperatures and low cycle fatigue tests at 375 °C for Zr-4 and Zr-1Nb alloys were carried out, then monotonic and cyclic constitutive relationships and Manson-Coffin life-estimating expressions for two alloys were given. The results show that the Young's modulus, yield stress, tensile strength, and strain hardening decrease significantly with increasing temperature, however, the higher temperature is, the less effect of temperature on the strain hardening for Zr-4 is. The uniaxial properties of Zr-4 were hardly affected by the strain rate at 375 °C. Under constant strain amplitude cycling, Zr-4 presents cyclic hardening especially at lower strain amplitude. Zr-1Nb shows cyclic hardening at lower strain amplitude, however it exhibits cyclic soften at higher strain amplitude. Comparing to the monotonic tension behavior, Zr-4 presents cyclic strain hardening evidently at different temperatures.

**Key words** [Zr-1Nb alloy](#) [Zr-4 alloy](#) [low cycle fatigue](#) [thin-walled tube](#) [life estimation](#)

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