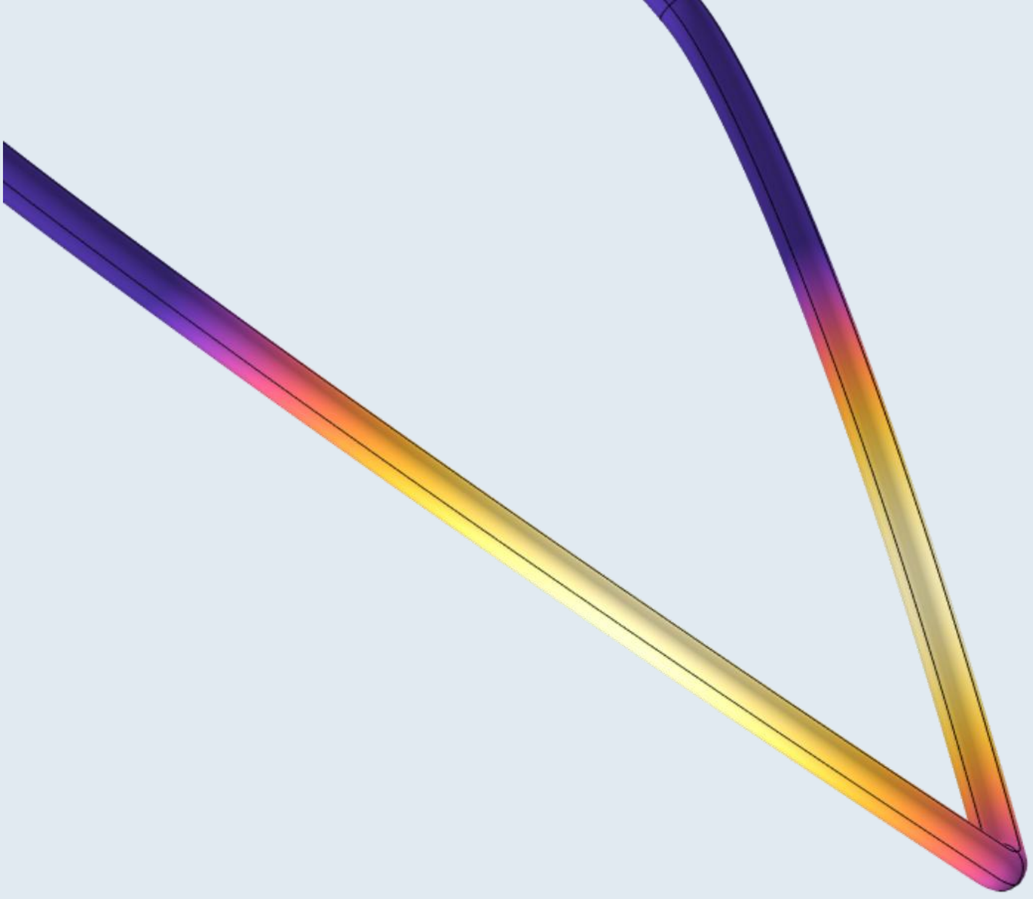

Analysis of Electron Gun Tungsten Filament in 3D

For many thermal design engineers, electromagnetic heating is an effective coupling method. When considering tungsten filaments, using these structures may be beneficial as they are easy to apply and provide useful results.

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Abstract

Tungsten wire is a key material for the cathode filament of early thermal emission electron sources. The filament diameter commonly used in engineering components is 0.127-0.203mm, and it is generally made into a V-shaped fork.

This work explains the engineering problems of common filament melting points and non filament needle tips, and optimizes that when the filament bending angle α tangent tan α=2:1, the temperature double peaks on the filament diameter are relatively concentrated, and the utilization efficiency of the electron gun is high. The calculation results provide theoretical reference for engineering applications such as cathode structure design and life prediction of electron sources.

Methodology

The model constructed a three-dimensional geometric structure of the filament, and during the calculation process, the area at the bending angle of the filament was subjected to mesh refinement. By combining the electromagnetic thermal module of COMSOL Multiphysics with multiple physical fields, the temperature distribution simulation calculation of tungsten filament was achieved, and the influence of different geometric structures and filament materials on the filament temperature distribution was further calculated.

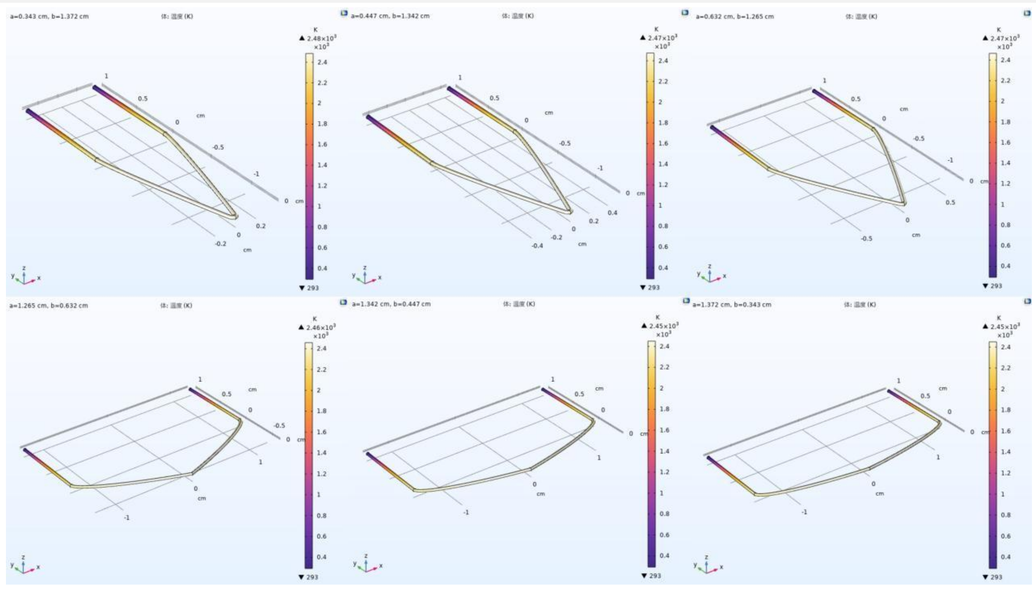

FIGURE 1.Temperature distribution diagram of tungsten filament with varying geometric angles

Results

The simulation results show that under the conditions of tungsten (W), titanium (Ti), zirconium (Zr) and various bending angles, the maximum temperature of the filament and the temperature difference at the bending point remain stable at around 30-40 K. From the trend, the smaller the bending angle α, the higher the total temperature of the filament.

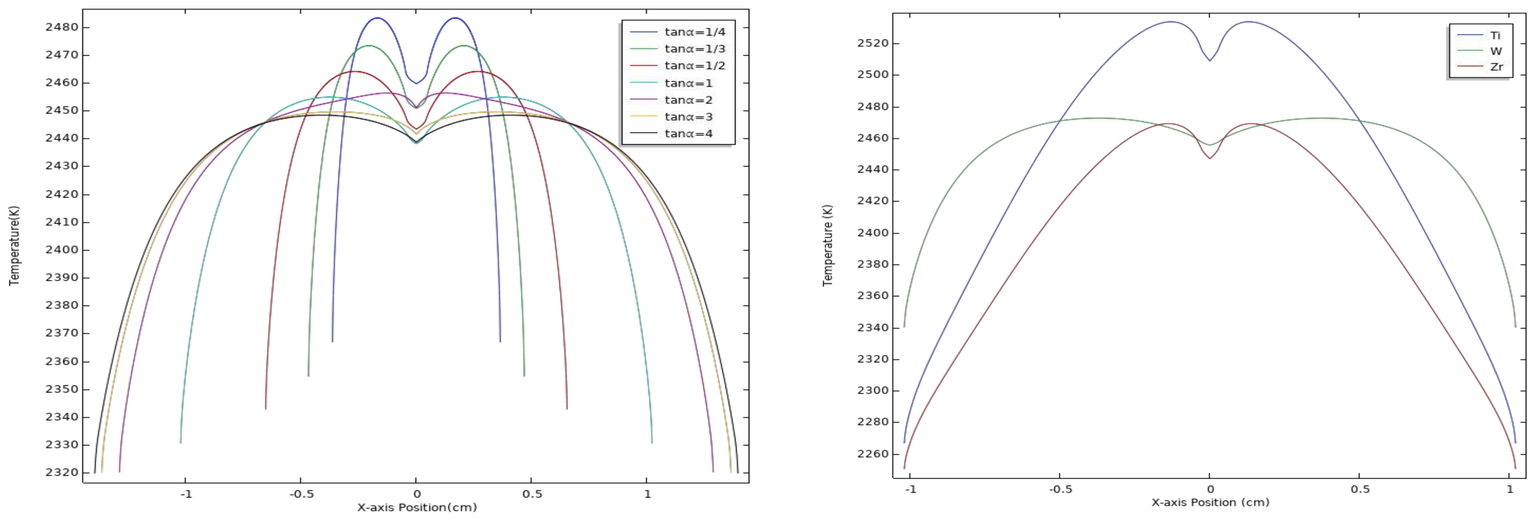

FIGURE 2.Left:Temperature distribution data chart of the outer end of the tungsten filament with varying deflection angles(where α is the angle between the central axis and the tungsten filament). Right:Temperature distribution data chart of the middle section line at the outer end of the filament for Ti, W, and Zr materials.

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