

## Simulation research on temperature field distribution of electric heating non-combustion cigarette heater

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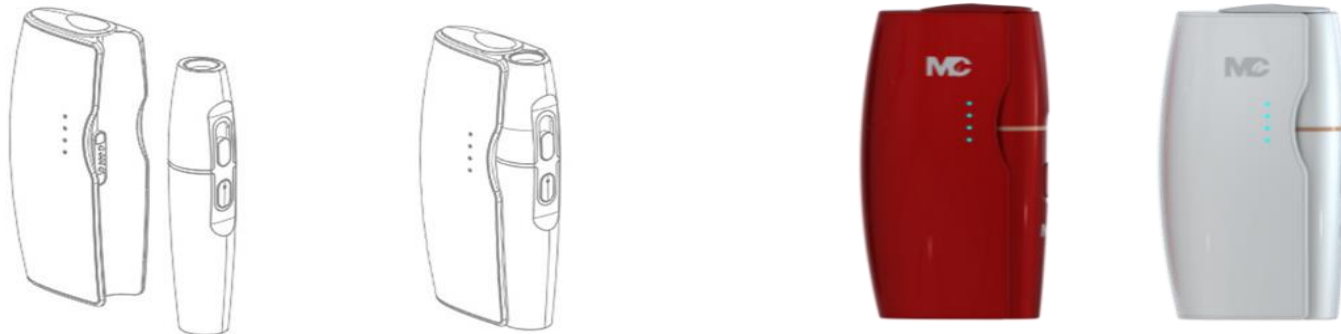
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# 1. Background

- ❑ With the increasing efforts of **global tobacco control**, consumers' awareness of **the safety of smoking** continues to improve. Many tobacco companies regard the research and development of **heating non-combustible tobacco products** as a strategic breakthrough.
- ❑ Compared with traditional cigarettes, heating non-combustion cigarettes only **heat tobacco materials or tobacco extracts** rather than burn. The **harmful substances** released from the smoke of heated non-combustible tobacco products are **greatly reduced**. Heating new tobacco products to release volatile aroma components can provide consumers with **certain tobacco characteristics**.



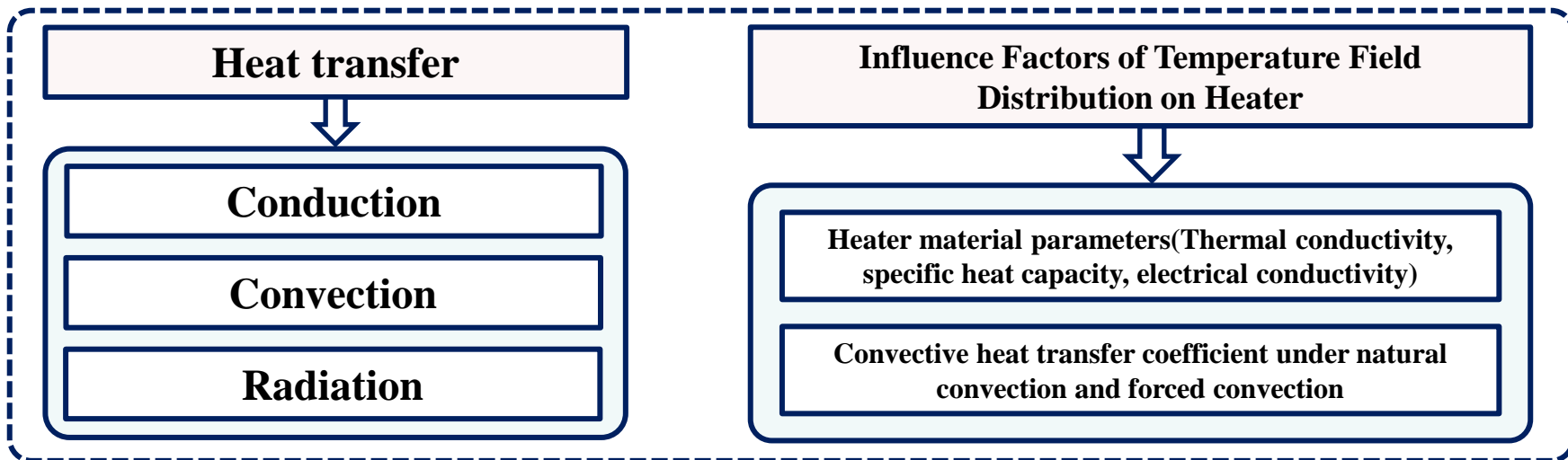
- In-depth study on the characteristics of temperature heat transfer mechanism and temperature distribution variation of heating non-combustion cigarette is the key to breaking through the problems of large energy consumption, high cost and inaccurate temperature control of electric heating non-combustion cigarette, which has important theoretical research value and economic significance. It is directly related to the optimization and design of the subsequent electric heating non-combustion cigarette heater, the heat transfer characteristics of the operating conditions and the effectiveness of the optimization control strategy. It is also the fundamental way to solve the poor performance stability and consistency of the heating non-combustion cigarette products.**





## 2. Simulation Method of Temperature Field Distribution

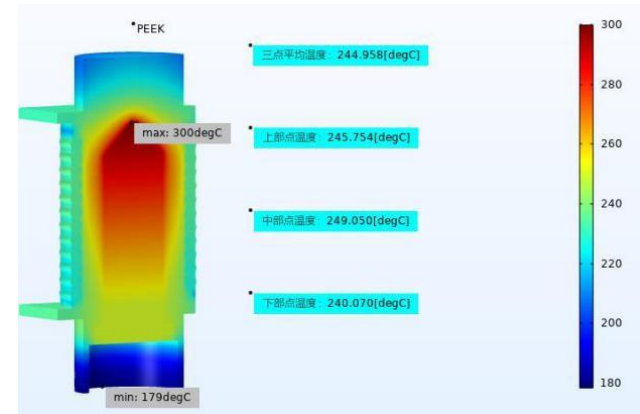
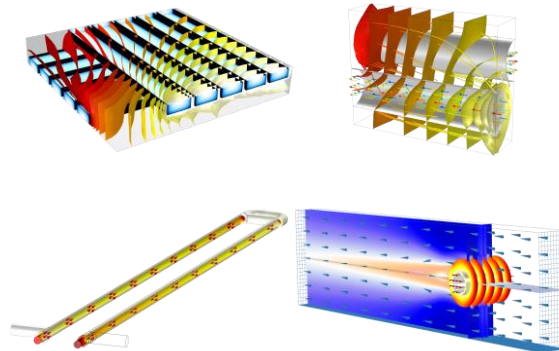
- ❑ In order to study the characteristics of temperature field distribution of electric heating non-combustion cigarette heater in heating state better and faster, COMSOL Multiphysics simulation software is used to study the temperature field distribution of micro heaters with different structural sizes and materials in the process of no-load natural heat transfer, and the simulation results are compared with the experimental results to verify the reliability of the simulation.





# MCOL Simulation Method of Temperature Field Distribution

❑ **COMSOL Multiphysics** is widely used in scientific research and engineering calculation in various fields, simulating various physical processes in science and engineering fields. It is based on the finite element method and uses mathematical methods to solve the physical phenomena in the real world. The software has a large number of predefined physical application modes, ranging from fluid flow, **heat conduction**, structural mechanics, electromagnetic analysis and other physical fields, which can help users establish models quickly.

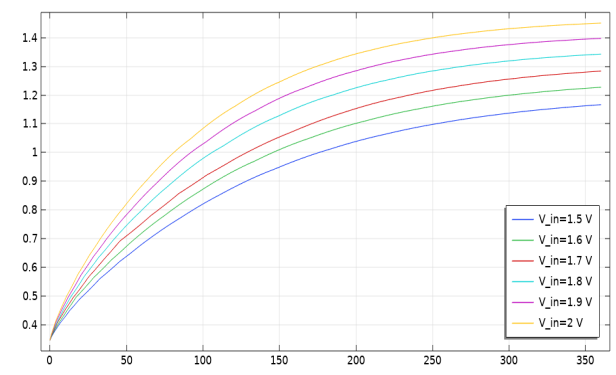
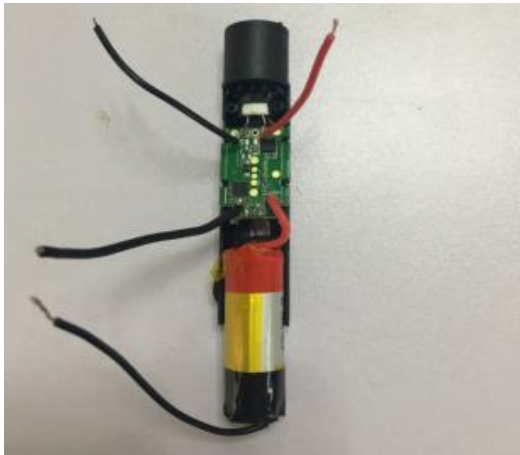




# MCOL

## Simulation Method of Temperature Field Distribution

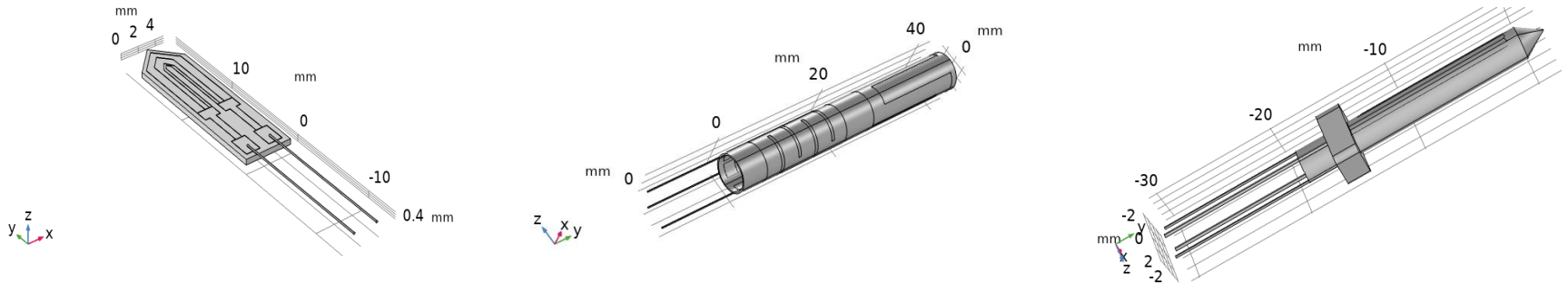
By establishing **the simulation model** of temperature field distribution of heating devices with different shapes and structures, the temperature field distribution of heating devices with different structures, sizes and materials in **the process of no-load natural heat transfer** is simulated and calculated, so as to obtain the best temperature field distribution for cigarette heating. **Maximizing the thermal conversion efficiency** of the heating device to fully heat the cigarette under suitable temperature conditions, and the calculation **error is within 20%**.



## 3. Simulation research experiment process

- Six groups of geometric models of temperature field distribution of electric heating devices with **different structures, sizes and materials** were established. The temperature field distribution of heating devices **under different voltage operating conditions** was simulated and calculated. In the heating process, the temperature rise curve of the heating device substrate was studied, and the experimental results of the heating device in the actual heating process were compared and analyzed. The correctness and feasibility of the simulation process were further verified.

- The heating device structure is sheet structure, tubular structure and rod structure.

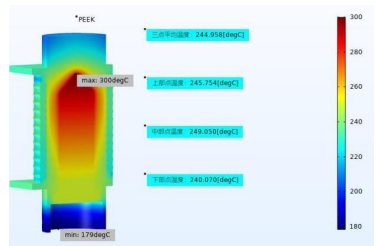
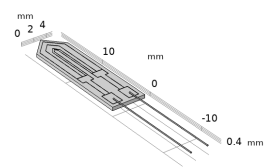
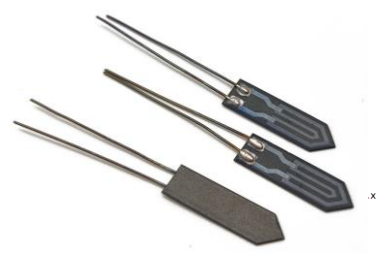
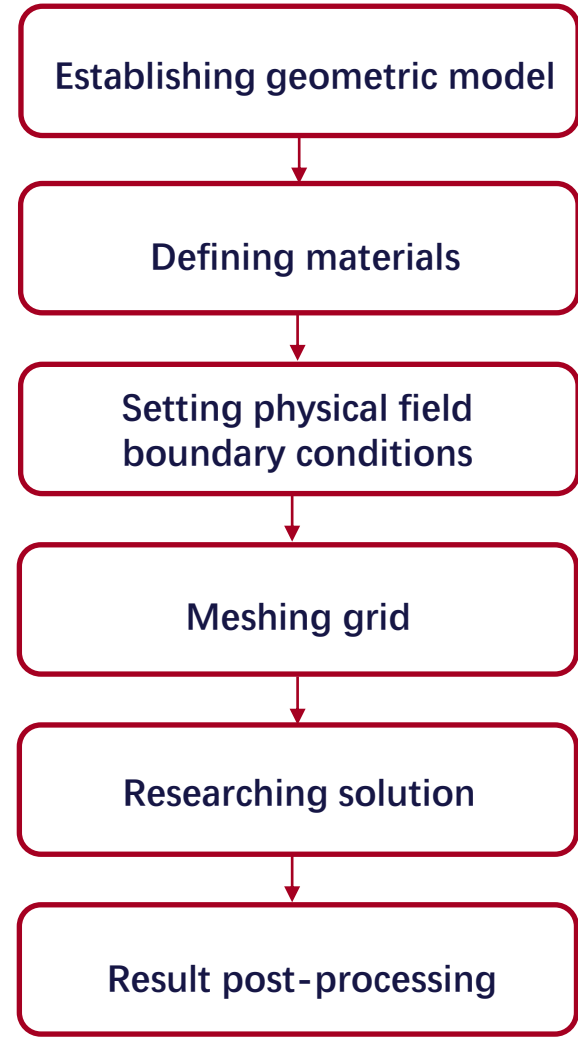


- The following will introduce the simulation process of 6 groups of electric heating devices with different structures, different sizes and different materials in the research process. The heating material is printed on the substrate and connected with the conductor at the connection to form a circuit to generate current heating.

Table 1 Heater materials and size parameters

Heater Form	Heating Material	Basic Body Material	geometrical dimension(mm)
#1Heating sheet	Tungsten paste	92%alumina	19.3×5×0.5
#2Heating sheet	Platina paste	95%zirconia	19.3×5×0.5
#3Heating sheet	silver-palladium paste	430stainless steel	19.3×5×0.5
#1Heating tube	silver-palladium paste	430stainless steel	Φ6.0×0.2×43
#2Heating tube	Tungsten paste	92%alumina	Φ6.0×0.2×43
#1Heating rod	Tungsten paste	92%alumina	Φ2.1×19

□ In the simulation process of temperature field distribution of electric heating non-combustion cigarette heater, it is roughly divided into the following steps: establishing geometric model, defining material, setting physical field boundary conditions, meshing grid, researching solution, and post-processing results.



## 4. Comparison of Simulation and Measurement Results

- Under the working voltage condition, several groups of heater models are instantaneously studied, and the calculation results are subsequently processed, and the parameters of different working voltages are scanned.
- Under different working voltages, the temperature field variation of the heater is explored, and the temperature rise curve of the heater is drawn. Finally, the simulation results and experimental results are compared and analyzed.

### Research Step

Explore temperature field variation

Drawn temperature rise curve

compared and analyzed results

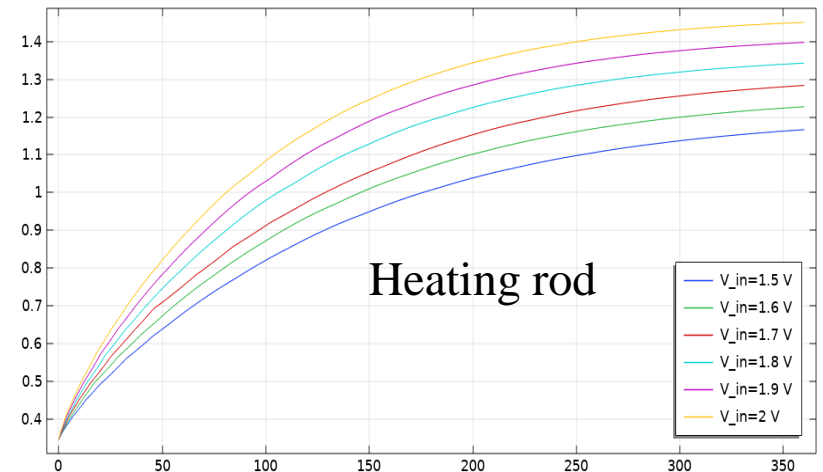
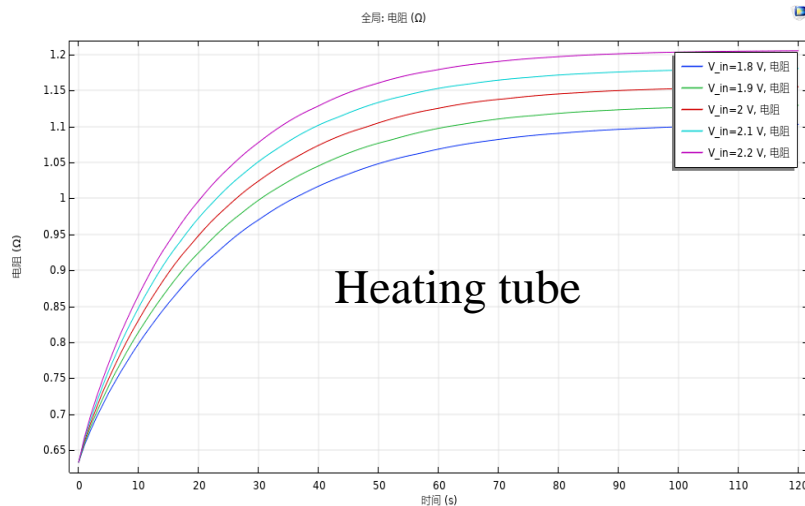
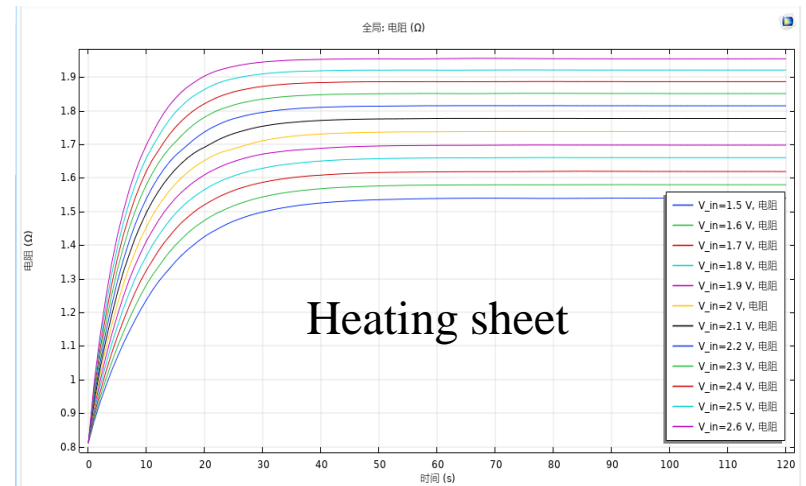






## The simulation results of three heating structures

Explore the heater temperature field variation under different operating voltages, and draw the heater temperature rising curve under different voltage conditions.



### The simulation calculation of the sheet heater

- ❑ In the simulation calculation of the plate heater, the setting of the scanning step size is 0.1 V.
- ❑ Under different working voltages, the temperature field variation of the heater is explored, and the temperature rise curve of the heater is drawn. Finally, the simulation results and experimental results are compared and analyzed.

<b>working voltage setting</b>	
<b>#1 and #2</b>	<b>1.2~1.6V</b>
<b>#3</b>	<b>1.5~2.6V</b>

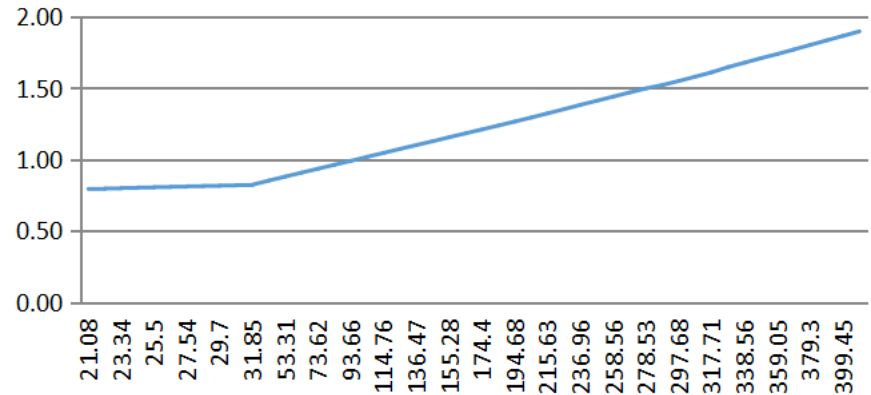


Fig 1 Experimental results

### The simulation calculation of tubular heater

- In the study of tubular heaters, two sets of tubular heater models were transiently studied under the working voltage of 2.2 V.
- The temperature distribution on the surface of the heater was plotted on a drawing group, and the parameters of different working voltages were scanned.

**Working voltage setting**

**1.8~2.2V**

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**Scanning step size**

**0.1V**

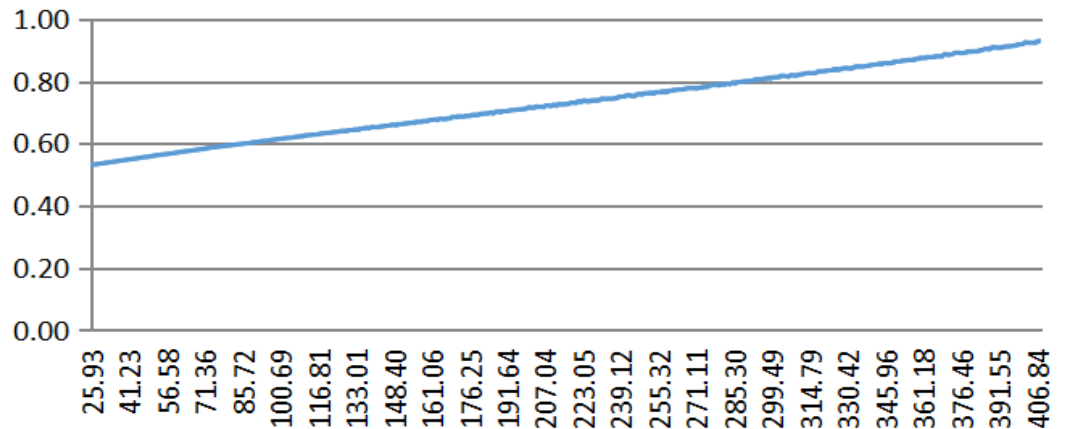


Fig 2 Experimental results



## 5. Conclusion



- ❑ In this paper, the electric heating non-combustion cigarette heater is taken as the research object, and the temperature distribution of the heater under different operating conditions is deeply analyzed.
- ❑ The temperature distribution of different heater models can be studied by COMSOL software simulation, and the accurate simulation real value is obtained.
- ❑ The research results of this paper can provide theoretical guidance for the optimization and design of electric heating non-combustion cigarette heater, and further promote the development process of this product in China.

Analyze mechanism

Simulate distributing  
trend

Promote the  
development

Thanks for listening!