

High Temperature Brazing Using Co Based Alloy Filler for Scandia Doped Dispenser Cathode Application



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1. Introduction

- —Joining of the cathodes and sleeves

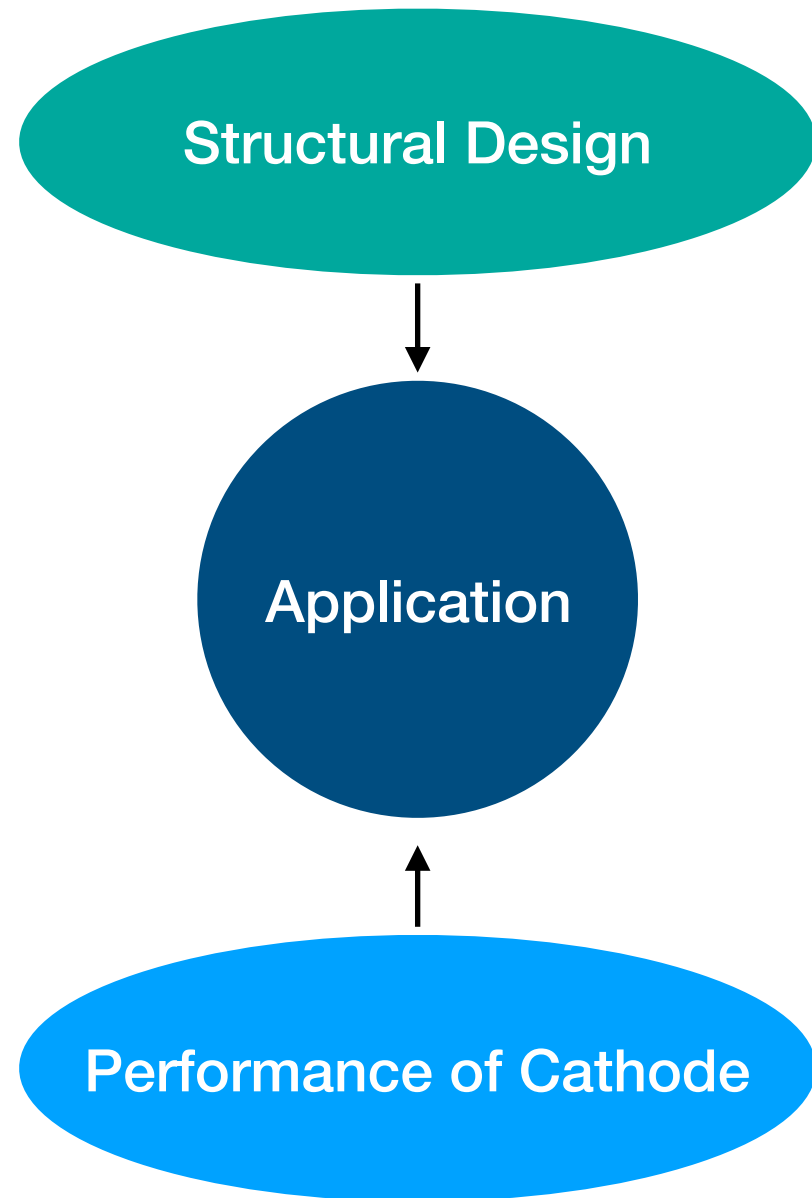
2. Experiment

- —Preparation of Co-W/Mo filler
- —Brazing of the assembly

3. Results

- —Melting points of the filler
- —Performance of the cathode after brazed
- —Possible analysis of volatilization and diffusion of filler

Introduction



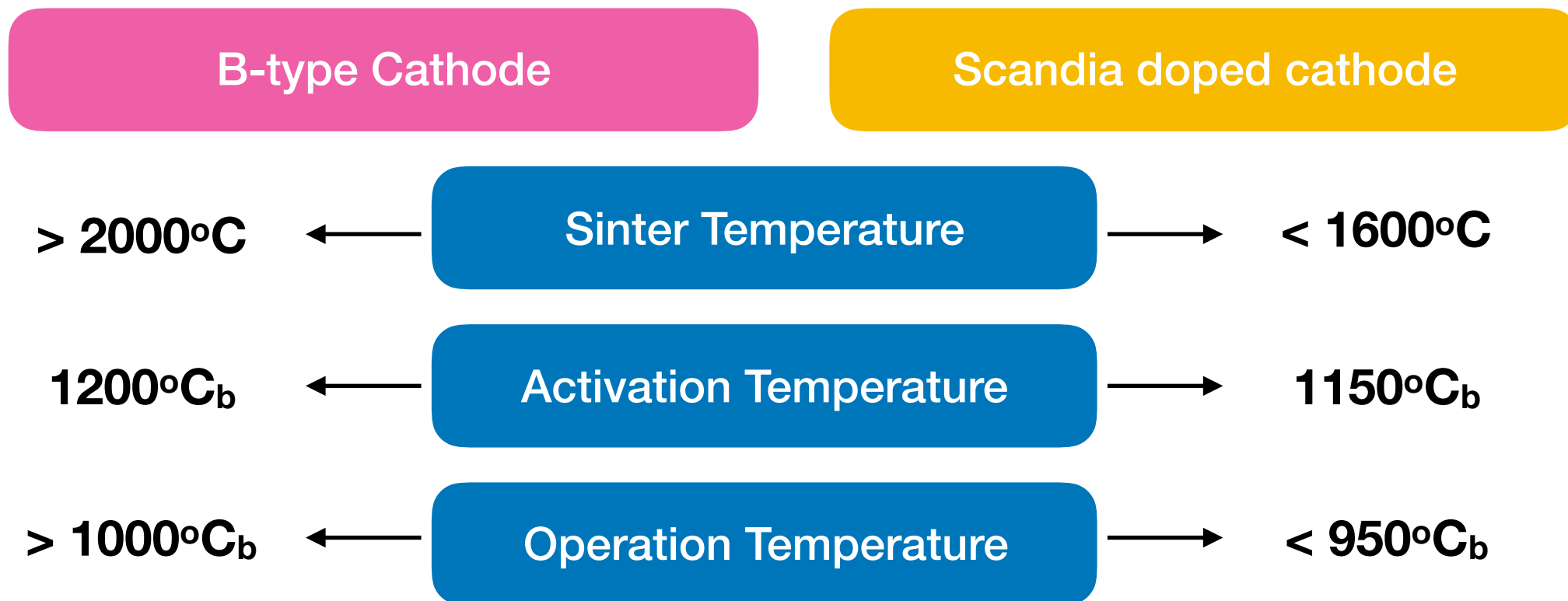
The applications of cathodes in the VEDs rely on both emission properties of cathode and the structure of assemblies.

Laser welding and brazing are common ways to joining the B-type cathodes and the sleeves, while the brazing is better in terms of precision and consistency.

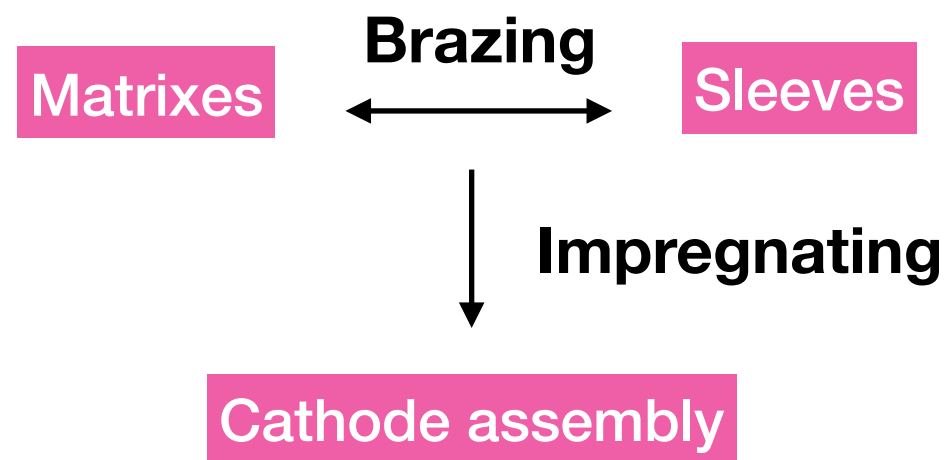
Filler	Component Mass Ratio (%)	Melting Point (°C)
Mo-Ru	80:20	1900
Pt-Ir	82.5:17.5	1822
Mo-Ru-Ni	61:31:8	1820
Pt-Ni	95.5:4.5	1735
W-Co	20:80	1500
Co-Ni	60:40	1469
Co-Cr-W-Ni	30:20:20:10	1430
Ni-Ta	63:37	1360
Mo-Co	37:63	1330
Mo-Ni	51:49	1315

Table. 1 The melting points of different fillers used in brazing of W/Mo

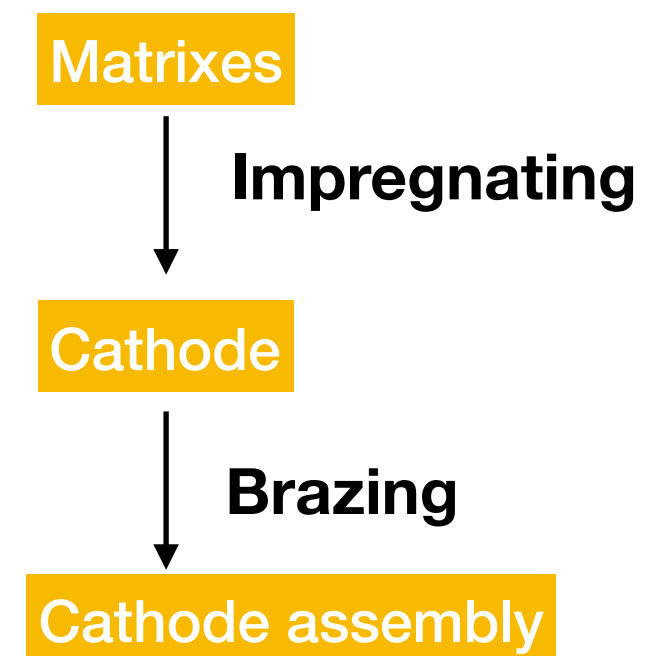
Introduction

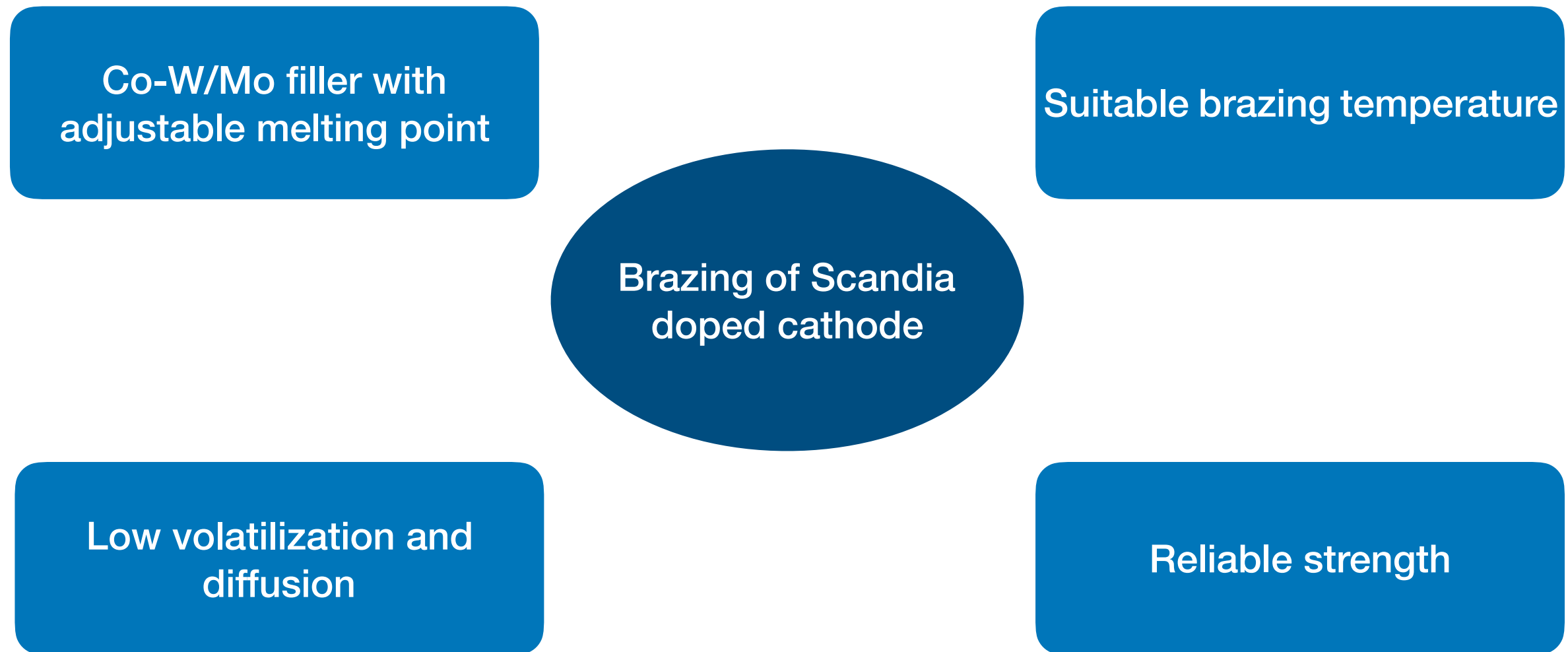


The preparation and operation temperatures of scandia doped cathode are lower than the B-type cathode, and ultra-high temperature is harmful to the structure of Scandia doped matrixes that sintered at lower temperature.



Limited by welding process, brazing has potential risks to the performance of Scandia doped cathode by change the impregnation.

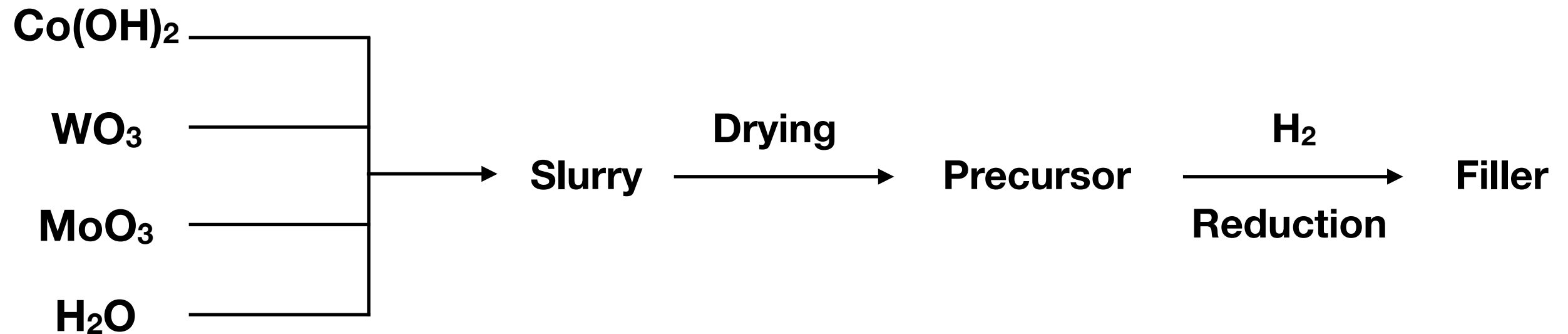




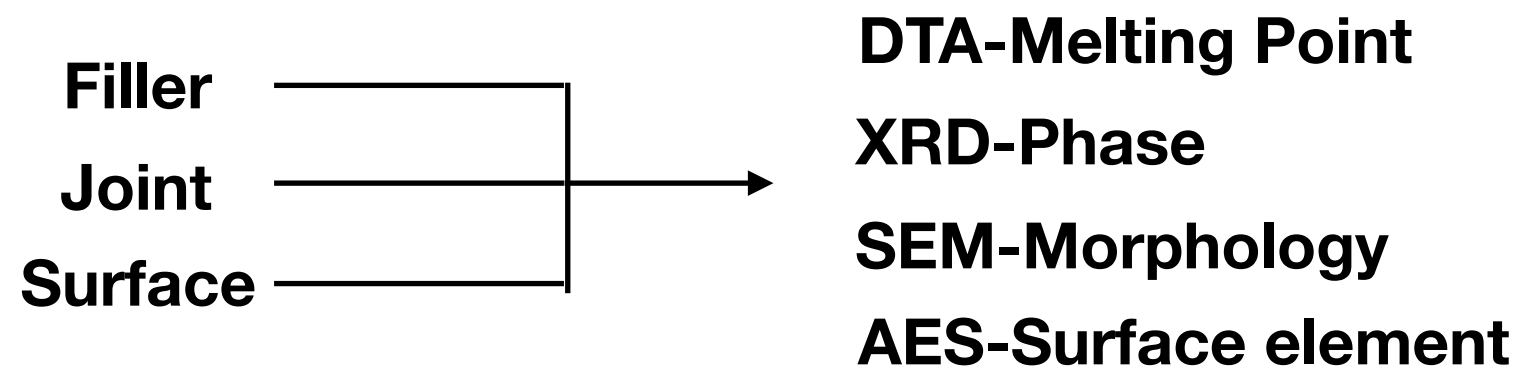
In this study, the Co-W/Mo alloys were taken as the solder for the cathode brazing.

Experiment

Preparation of the filler



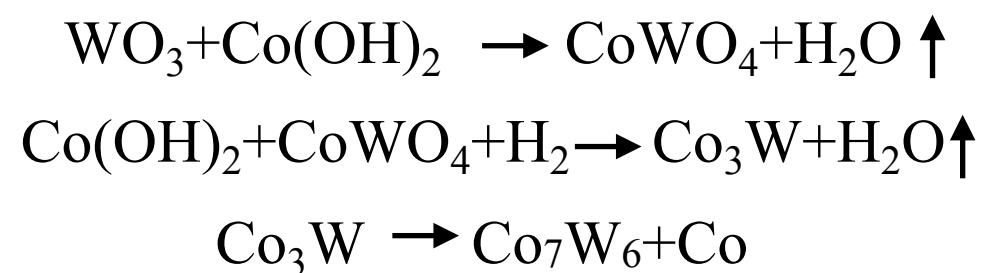
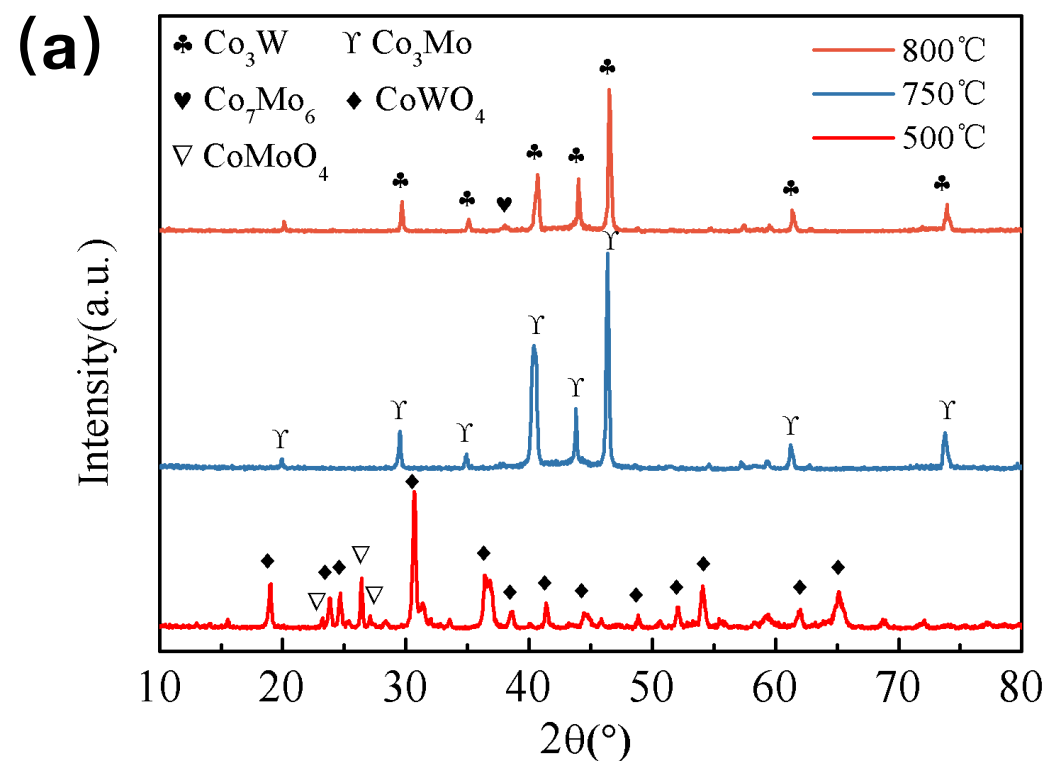
Feasibility analysis



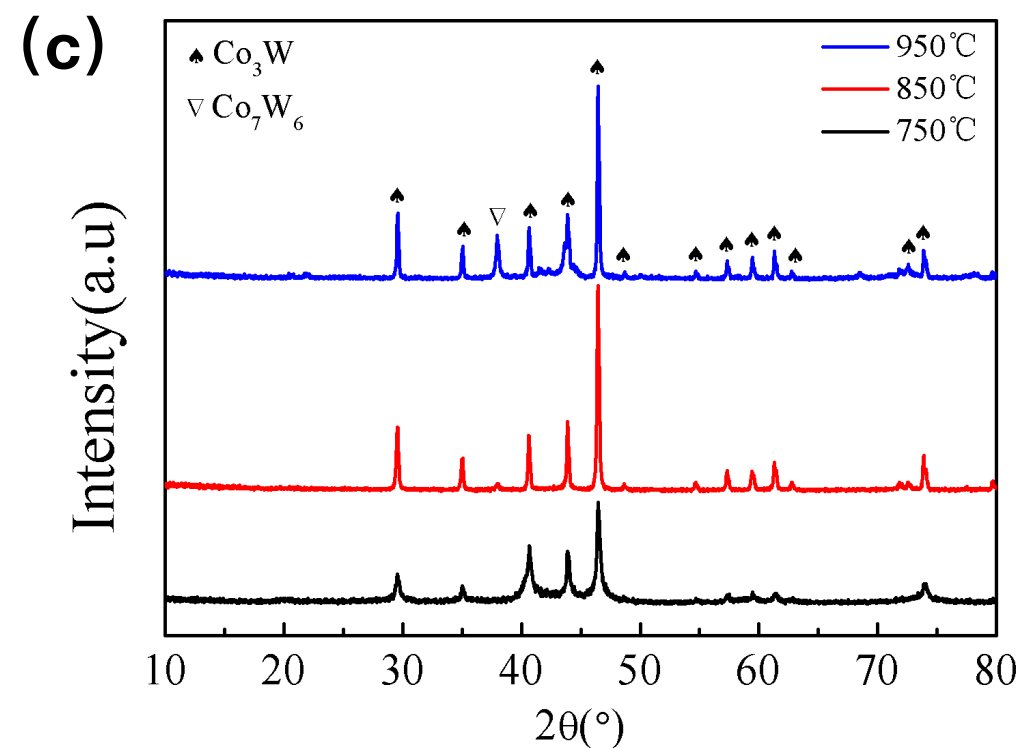
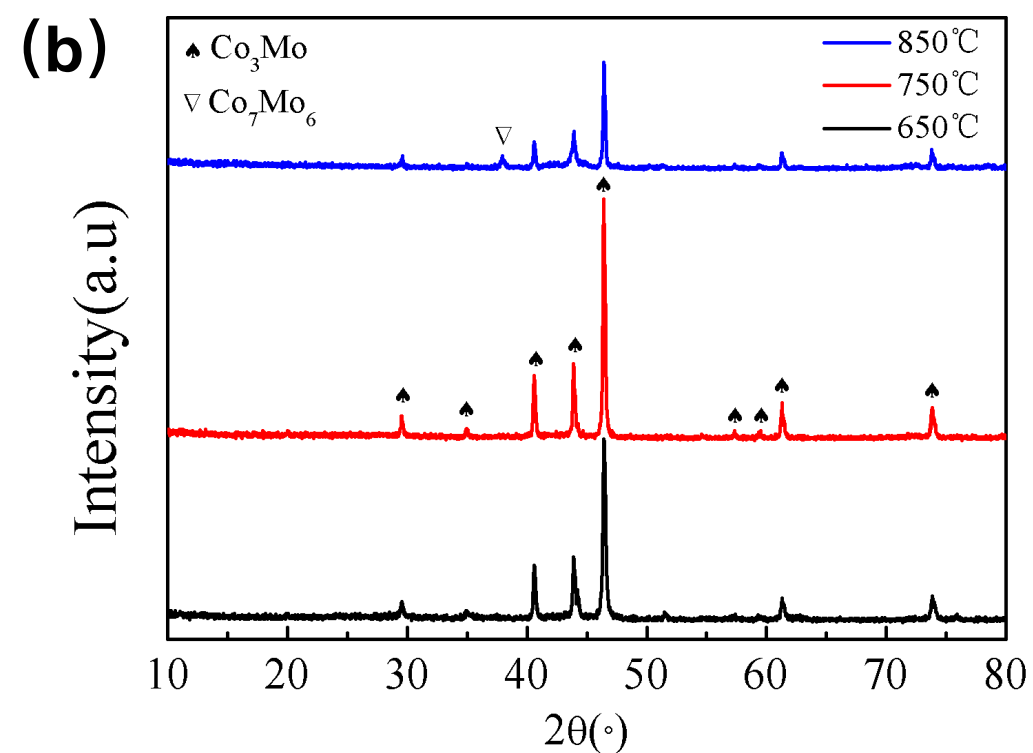
Calculation

Thermal Properties
Vapor Pressure

Result



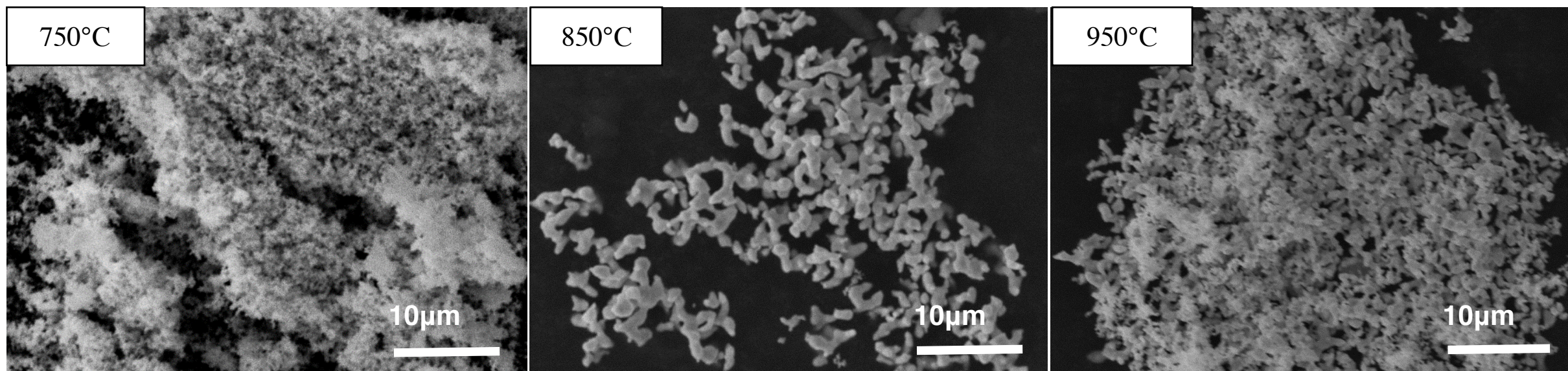
The XRD results indicate that the phase transformation of Co_x(W/Mo)_y during reduction



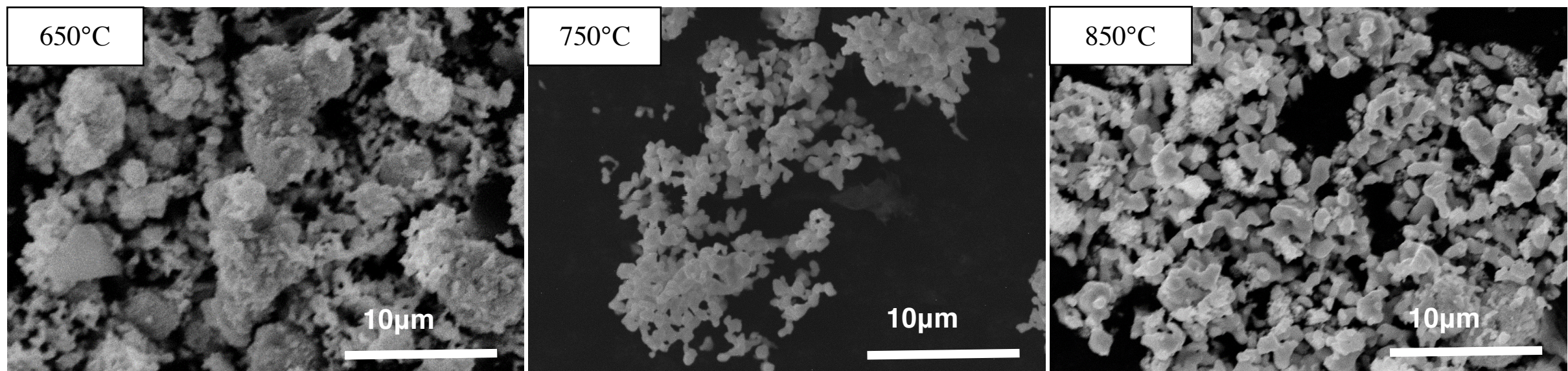
XRD of fillers that reduced at different temperature (a)Co-W-Mo (b)Co-Mo (c)Co-W

Result

W-Co Filler, Reduced at different temperature

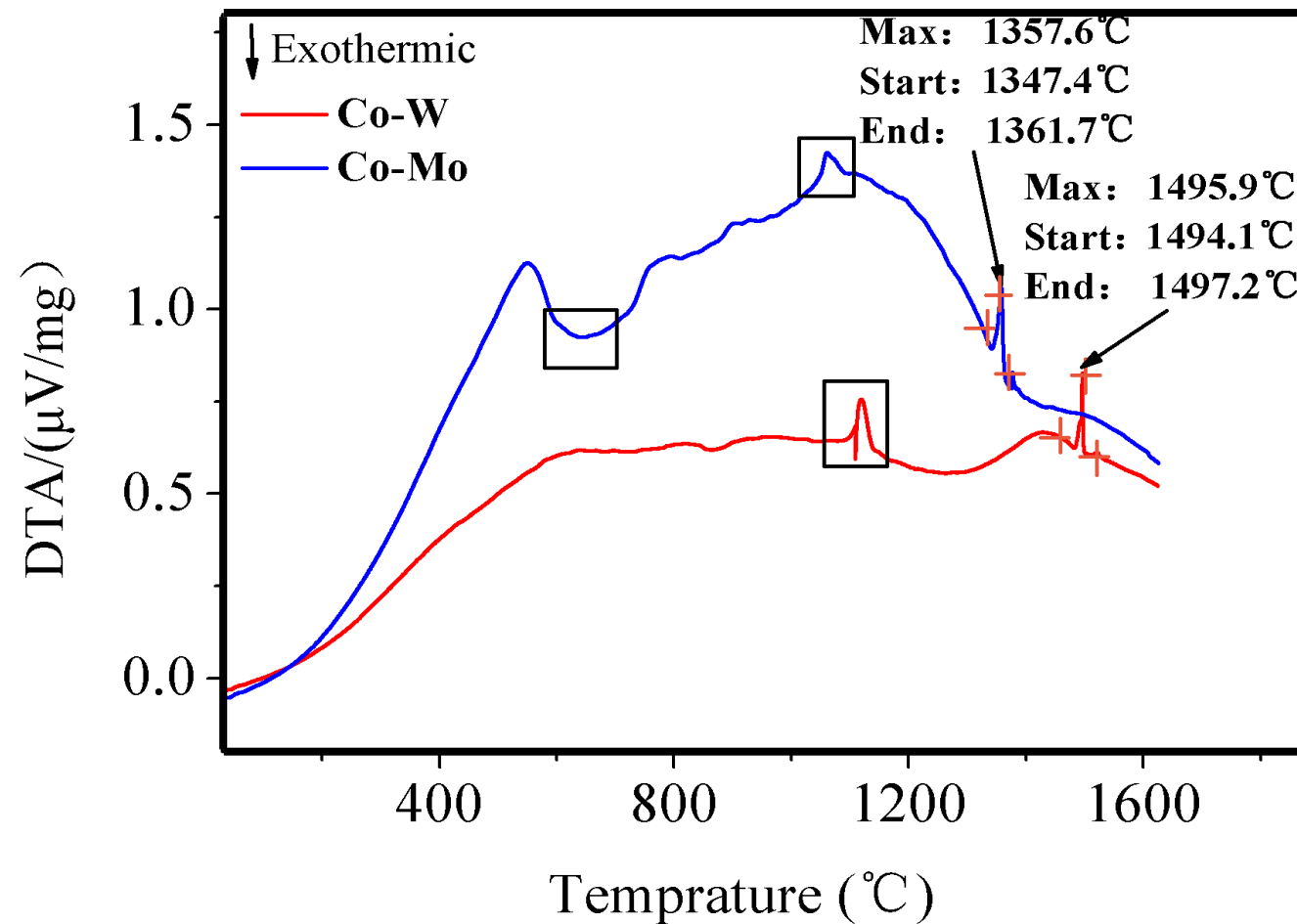


Mo-Co

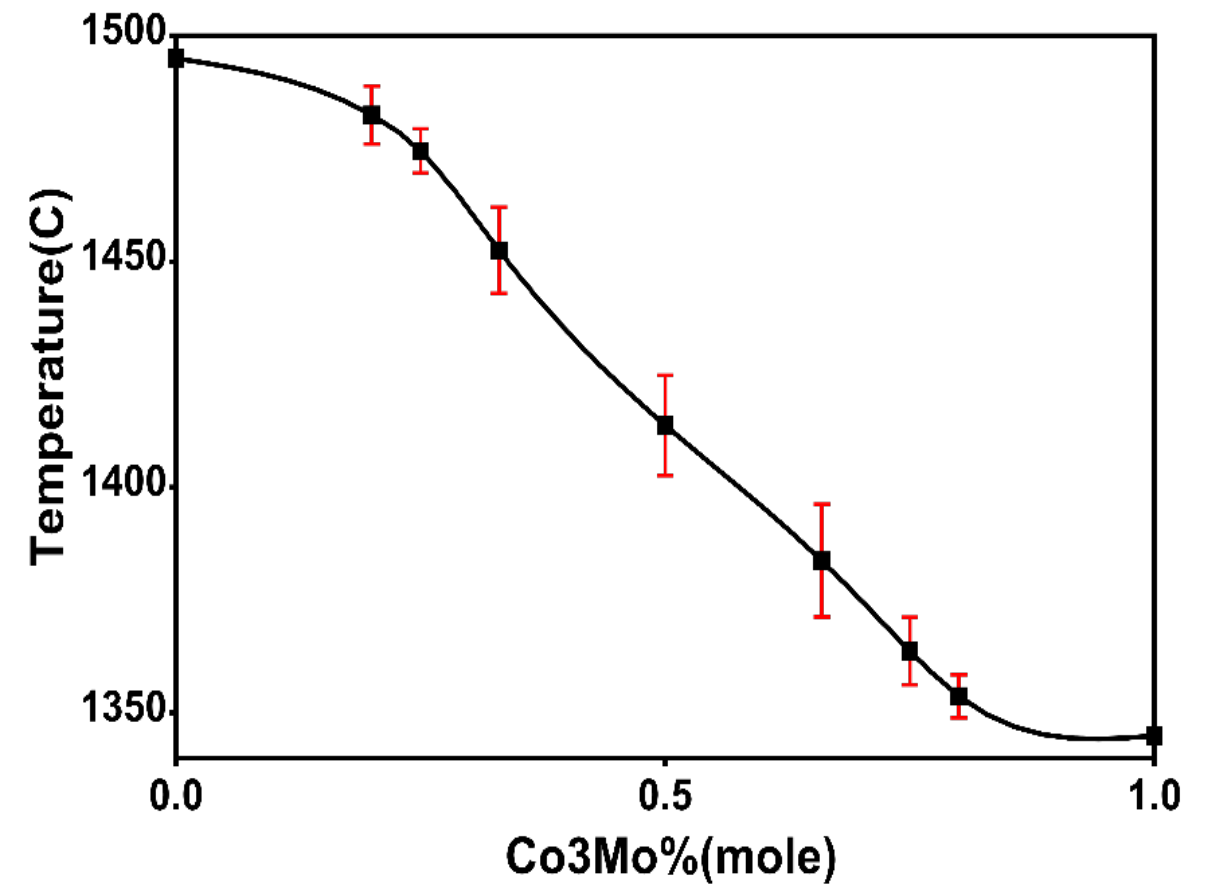


The particle size of Mo-Co filler are larger than that of W-Co reduced at same temperature.

Result



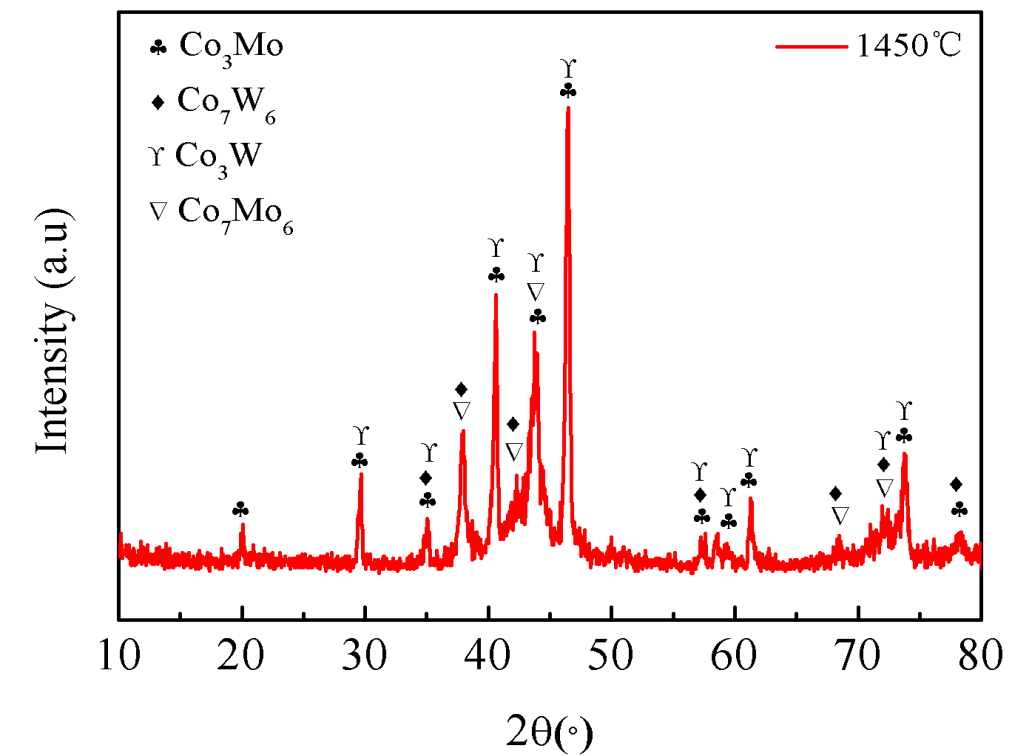
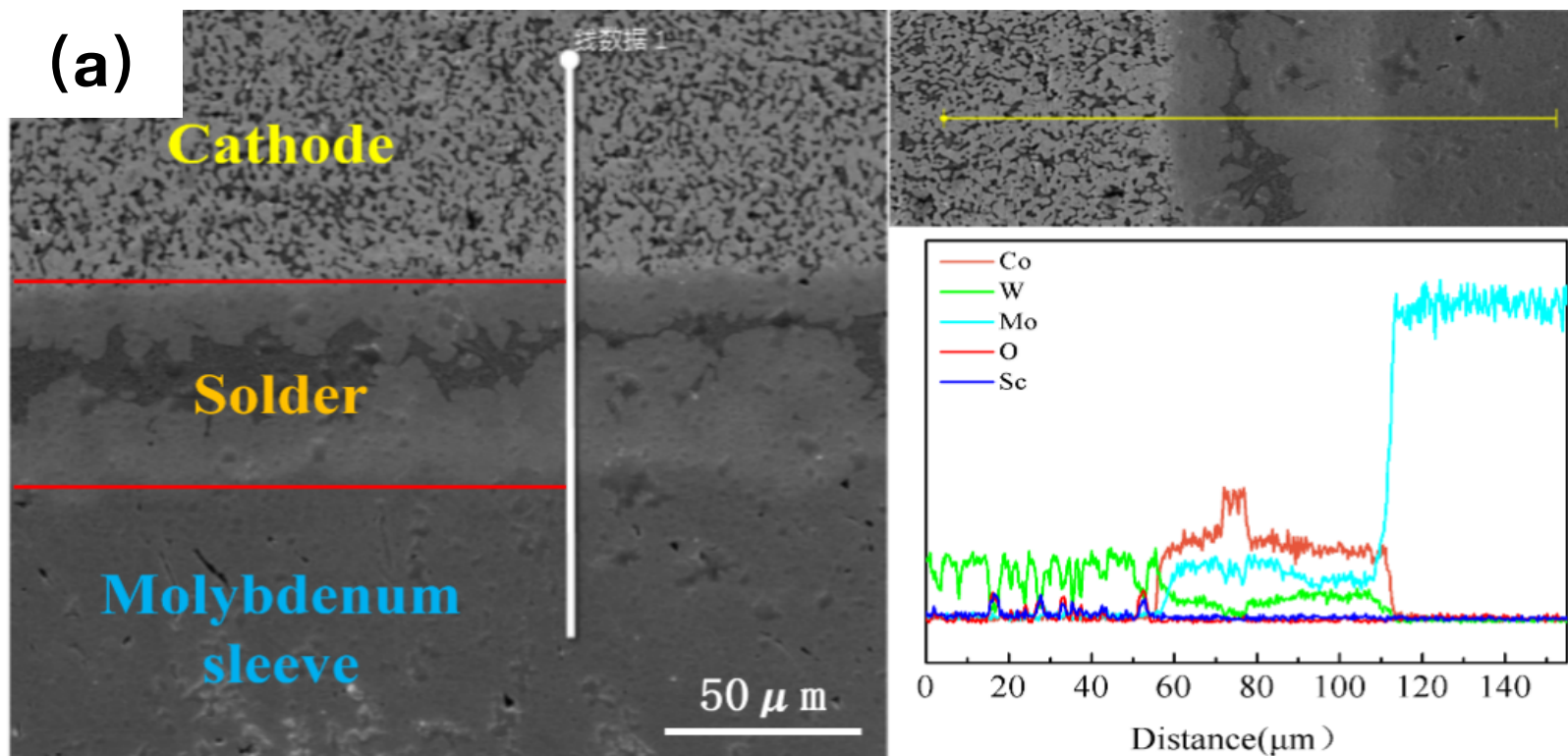
DTA results of Co-W and Co-Mo



Comparison of melting points and Mo% (mole) in Co-W-Mo fillers

The melting points of Co-W-Mo fillers are continuously adjustable from 1347°C to 1496°C through the control of molybdenum content.

Result

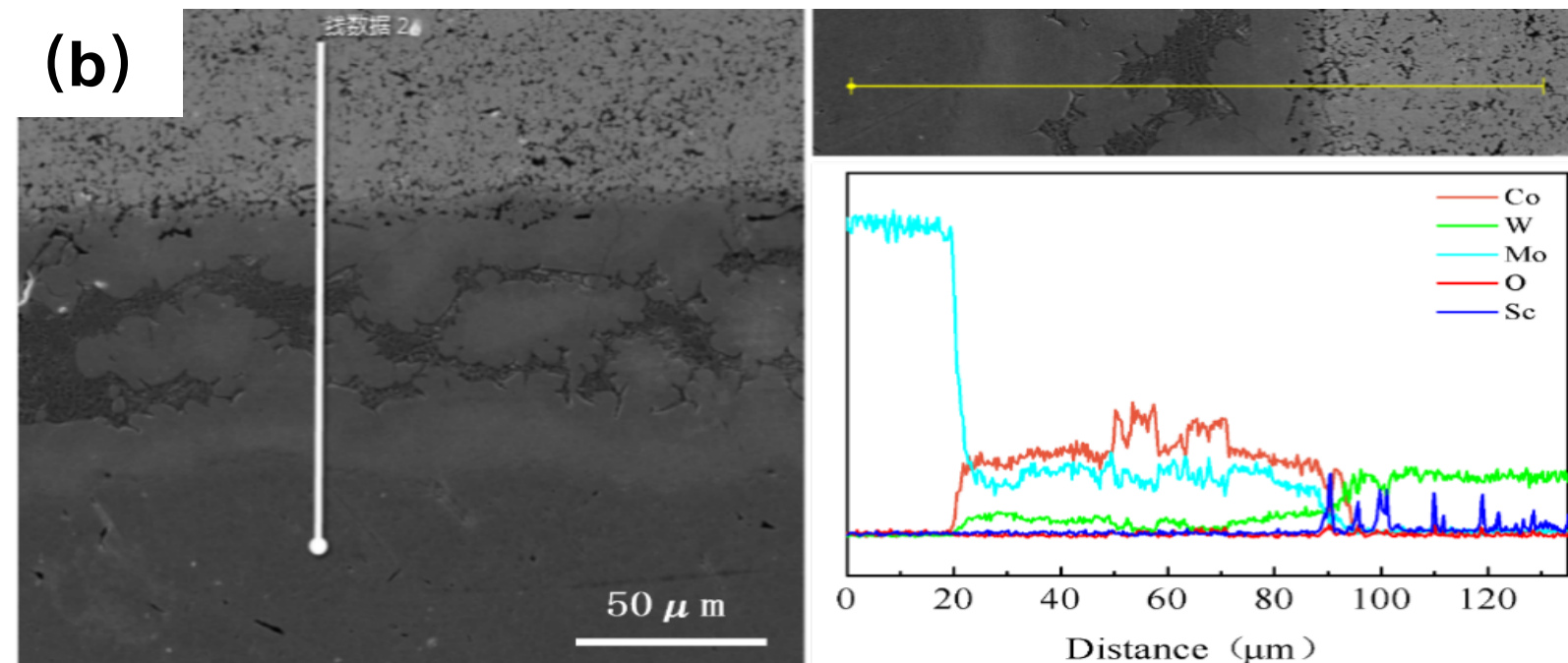


XRD of the filler at 1450°C

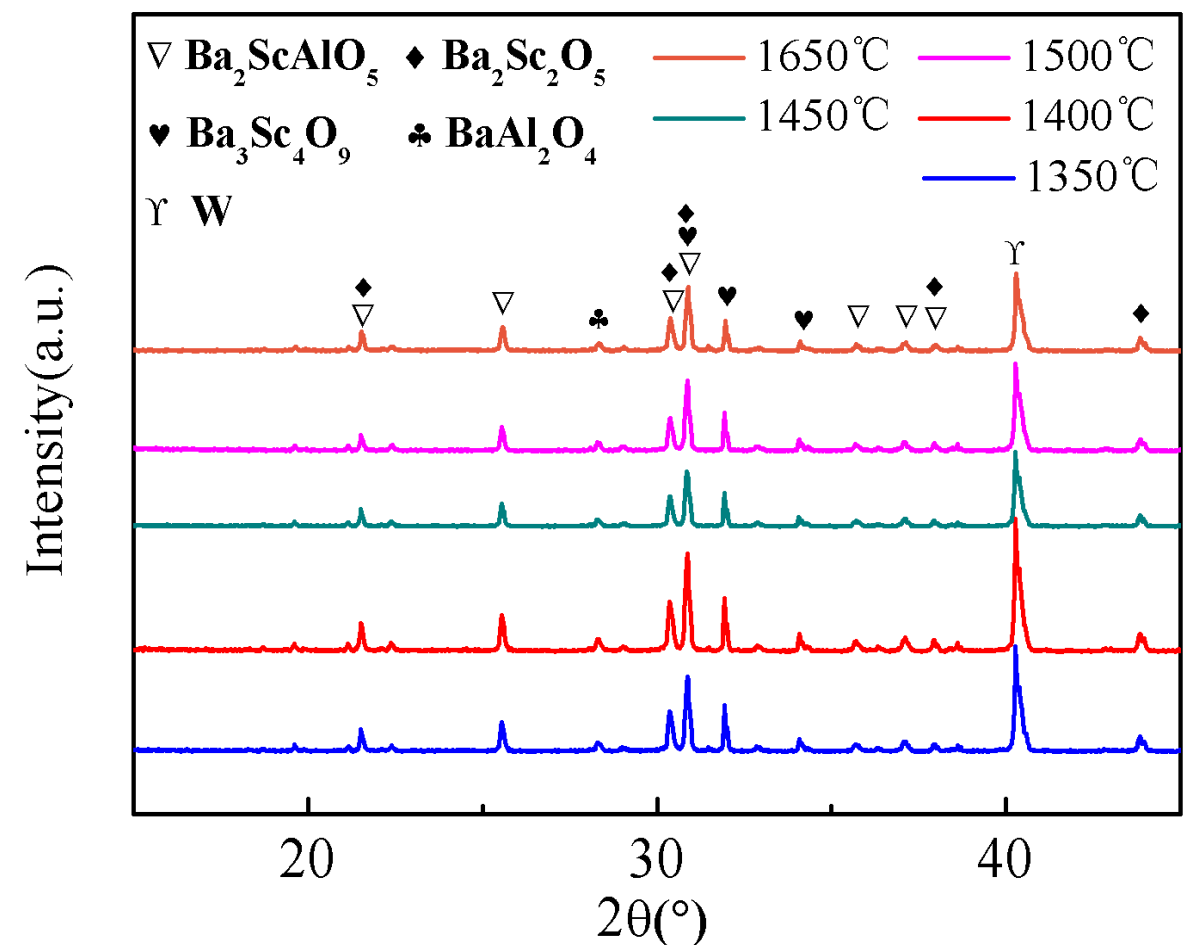
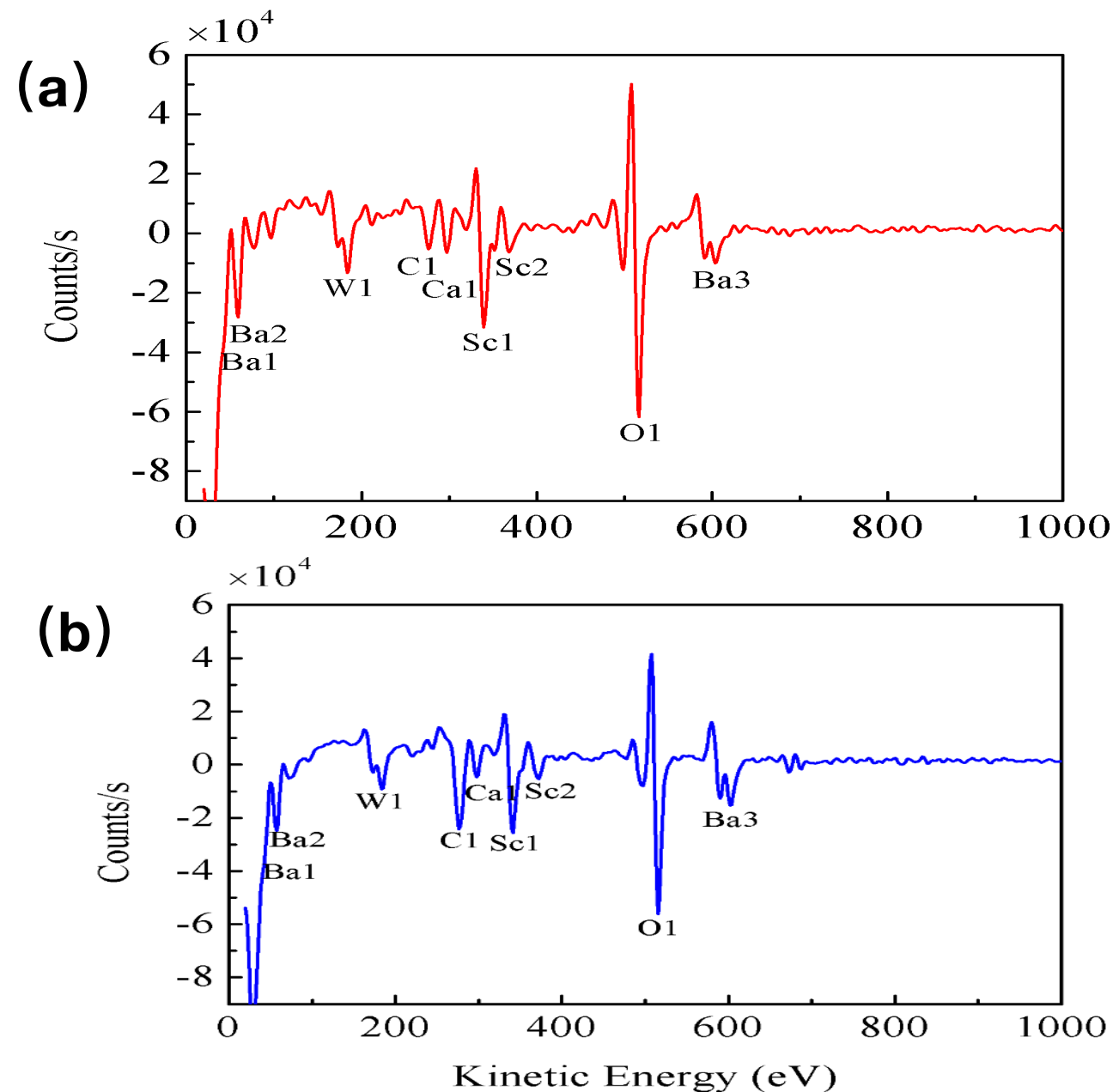
Co₇(W/Mo)₆ have the highest content in the weld.

With the increasing of brazing temperature, the weld width increase obviously. Which indicate that the solder reacted with base metal.

Typical morphology of the joints (a)1400°C (b)1450°C



Result



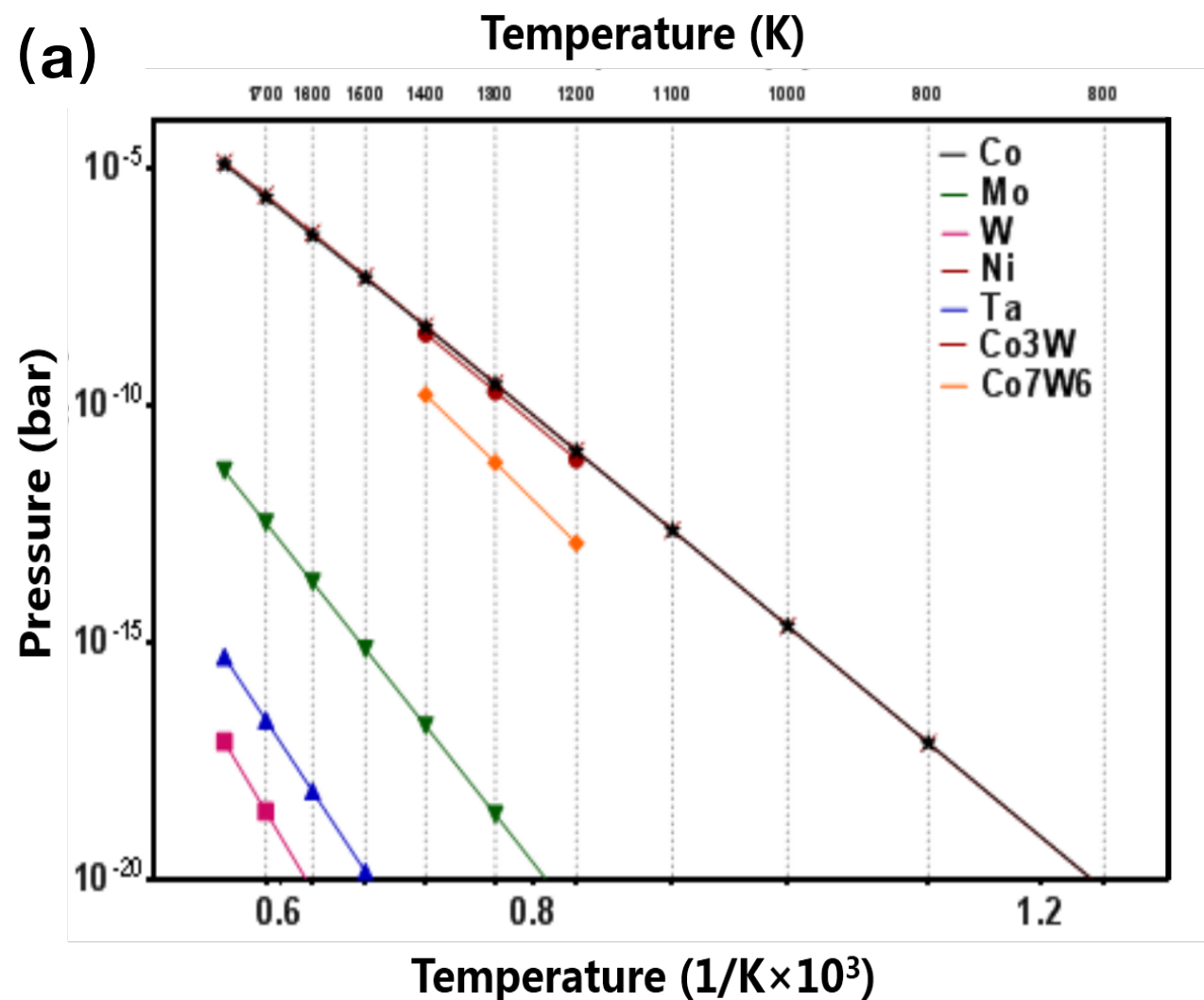
XRDs of the cathodes that brazed at different temperature

XRDs of the cathode indicated that the phases in the cathode keep intact after brazed.

AES results of cathode surface (a) brazed
(b) brazed and operated for 1000h

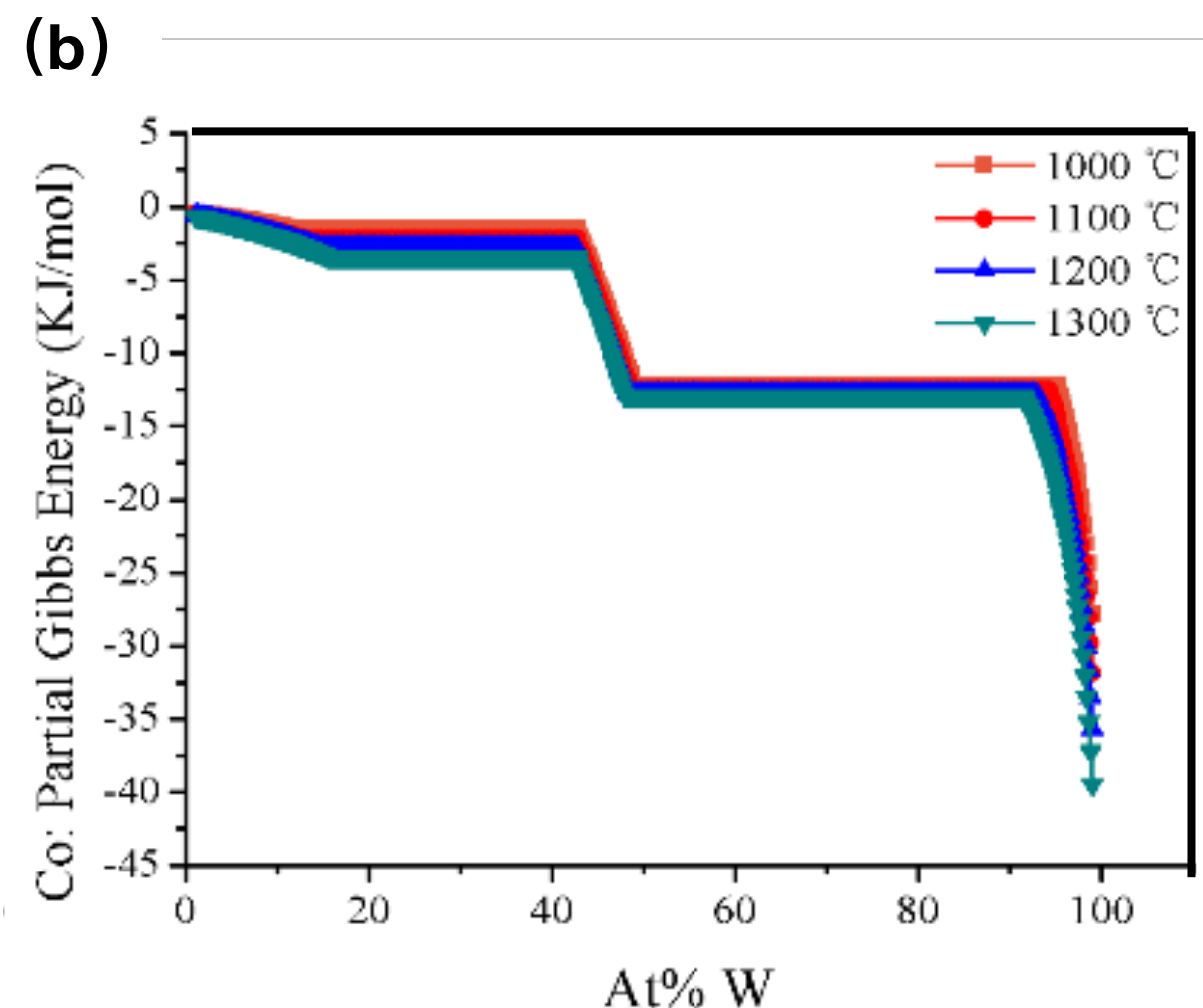
The AES results show that there are no Co impurities appeared on the surface of brazed cathode and even operated for 1000h.

Result



Vapor pressure of different solids

According to the thermal calculation, the formation of Co₃W and Co₇W₆ would limit the volatilization of Co slightly.



Chemical potential of Co in W-Co

With the penetration of Co to the cathode and sleeves, the chemical potential of Co decrease significantly, which means that it is harder to volatilize.

Conclusion

1. The melting points of filler with content of Co-W-Mo can be adjusted by the proportion of Mo from 1347°C to 1496°C continuously, which gives plenty of choices for the brazing of Scandia doped cathode.
2. The thermal processes of brazing from 1350°C - 1500°C have no influences to the phases of the impregnated cathode, and there are also no Co appeared on the surface of the cathode after brazing.
3. Due to the formation of $\text{Co}_x(\text{W}/\text{Mo})_y$ and the penetration of Co to W, the chemical potential of Co in the system decreased obviously, which resulted that the volatilization of Co is limited significantly.



Thank you!

7th IVEW & 13th IVeSC
