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Study the Co-C/Re-C Eutectics Fixed Point Measurements For High Temperature Radiation Thermometer

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Summary:
CMS/ITRI study a relative primary radiation thermometer for realization and dissemination of thermodynamic temperature above the copper point. The measurements was carried out using the facility of the Co-C eutectic fixed point and Re-C eutectic fixed point. Research is focused on delivering study the measurement capability of the eutectic point. In this thesis, we describe the steps of analysis, the method and results of measuring the spectral radiance of the blackbody radiation of Co-C and Re-C, and to understand uncertainties associated with cells repeatability and reproducibility.

Keywords: radiation thermometer, thermodynamic, eutectic fixed point, blackbody, uncertainty

Background

CMS study the thermodynamic temperature indirectly through HTFPs whose thermodynamic temperatures have been assigned either a prior or though calibration The relative method is elaborated in the text for the mise-en-pratique for the definition of the kelvin (MeP-K) [1, 2]. The implementation of relative primary radiometric thermometry requires the use of one or more fixed point blackbody sources. In this thesis, we describe the results of measuring the points of inflection of the melting transition curves of the metal-carbon eutectics Re-C, Co-C, and the same time understand associated with cells repeatability and reproducibility

Description of Experimental Configuration

The primary radiometry measurements at CMS will be carried out using: A Si-based radiation thermometer - linear pyrometer LP4 which made from KE is used in the experiment .The wavelength setting of the interference filter in the linear pyrometer LP4 is 650 nm. A set of high quality fixed-point blackbody sources: the Co-C (1324 ℃) eutectic fixed point cell and a Re-C (2474 ℃) eutectic fixed point cell -- Commercial type made from CHINO. A PID-controlled furnace (CHINO model IR-R80) system which use graphite as the element of the heater has the ability to create a stable environment temperature range from 1000 ℃ to 2800 ℃.

Measurement conditions

Melt and freeze steps will be presented below:

1. For a Re-C (2474 ℃) eutectic fixed point cell: The furnace would be heat up at 2500 ℃ for melting, and go down from 2500 ℃ to 2412 ℃ for freezing.
2. For a Co-C (1324 ℃) eutectic fixed point cell: The furnace would be heat up at 1340 ℃ for melting, and go down from 1340 ℃ to 1262 ℃ for freezing.

The measurement process is:

1. Repeatability: three melting plateau were realized in the same furnace on the same day
2. Reproducibility: three melting plateau were realized in the same furnace on 3 days

Results

The result of the points of inflection of the melting transition curves of the metal-carbon eutectics Re-C, Co-C is shown in Figure 1 and Figure 2 respectively.

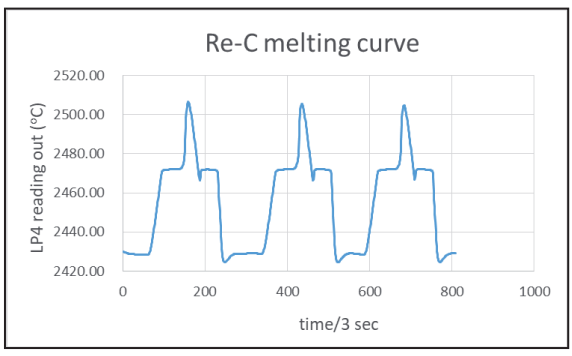

Fig. 1. . Re-C eutectic cell experimental result.

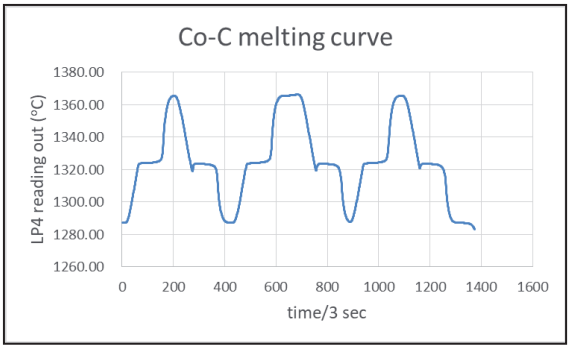

Fig. 2. . Co-C eutectic cell experimental result.

Analytic method is the third-order polynomial fit method [3]. A third-order polynomial is fitted (least-square method) to the data. Then, fitting coefficients can be used to calculate the time of point of inflection. Finally, the time of point of inflection is substitute back to the third-order polynomial to obtain the temperature. In order to fit the experimental result to the polynomial, it is necessary to select appropriate range of data. The data which we used for fitting is shown below. The fitting range of Re-C experiment is shown in Figure 3.

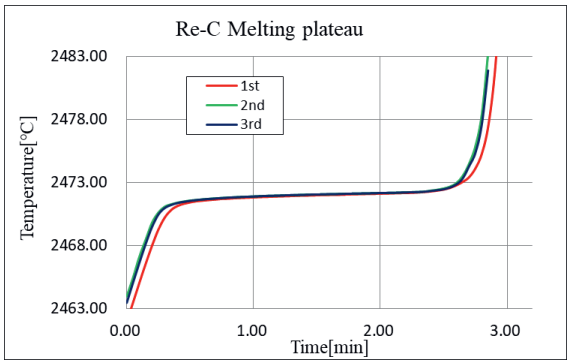

Fig. 3. . Re-C POI analytic result

The fitting range of Co-C experiment is shown in Figure 4.

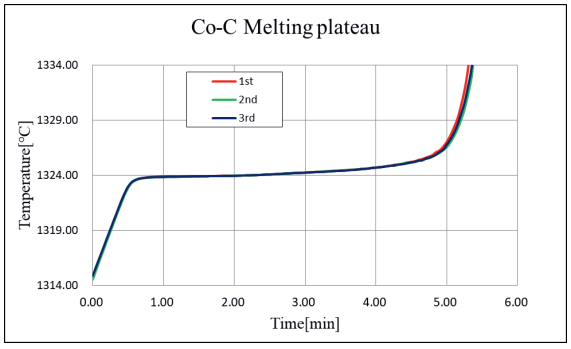

Fig. 4. . Co-C POI analytic result

Summary of the point of inflection uncertainty of the Re-C and Co-C cell is given in Table 1 and Table 2 respectively.

Tab. 1: Summary of Re-C cell uncertainty

Source of Uncertainty Re-C cell	U (k=1) /K
POI determination	1.39
POI Repeatability	0.06
POI Reproducibility	0.1857

Table. 2. Summary of Co-C cell uncertainty

Source of Uncertainty Co-C cell	U (k=1) /K
POI determination	0.96
POI Repeatability	0.015
POI Reproducibility	0.057

Conclusion

This paper has presented the results of the point of inflection of the melting transition of the metal-carbon eutectics Re-C and Co-C along with their cell effects uncertainties .In the near work, CMS will study the long-term stability tests on these cells and the uncertainties associated with furnace effects.

References

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