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Recording of a new phenomenon during the solidification of Mo, Si, and Ta via ultra-slow motion pyrometer cooling profile capturing in a custom-designed arc-melting setup

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a. Pyrometer details

- High T > 2000ºC phase transitions are difficult to measure.
- Pyrometer is the best option.
- Response time of the Pyrometer plays an important role in accurate phase transitions measurements.
- Table 2 gives the specifications of the Pyrometer in the current work.
- For Mo-Ta measurements, please refer our previous publications [1].

Property name	Property values
Response time, t_{95}	10 µs ± 5 ppm
Measuring range	350 …3500ºC
Spectral range	2.0 …2.20 µm
Emissivity, ε	Adjustable from 0.1 …1 in 0.001 steps
Optic	Fibre optics, 200 µm (black)
Aiming device	LED pilot light

Table 1: Specifications of Pyroskop 840, KLEIBER® infrared GmbH, Germany.

b. Custom-designed arc-melting setup

Figure 1a.: arc-melting front view

Figure. 1b.: arc-melting rear view

Figure 1c.: pyrometer position

C. Results and discussions

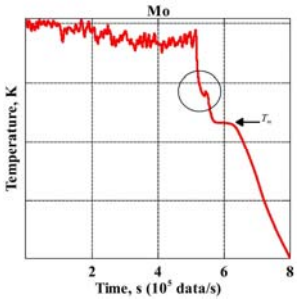

Figure 2a.: Cooling profile of Mo

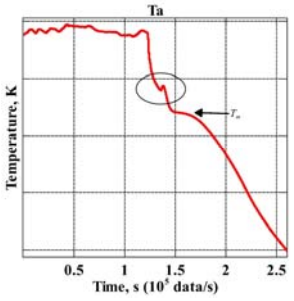

Figure 2b.: Cooling profile of Ta

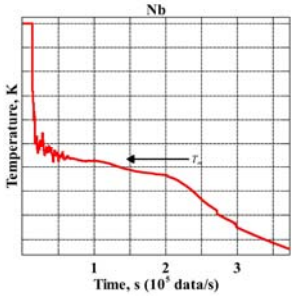

Figure 2c.: Cooling profile of Nb

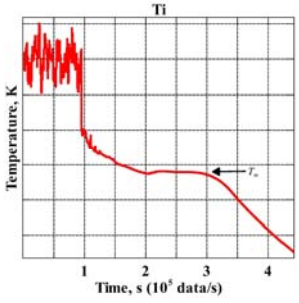

Figure 2d.: Cooling profile of Ti

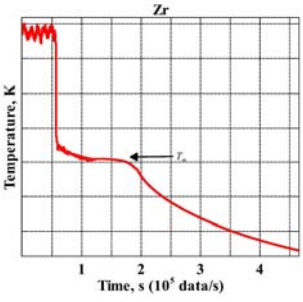

Figure 2e.: Cooling profile of Zr

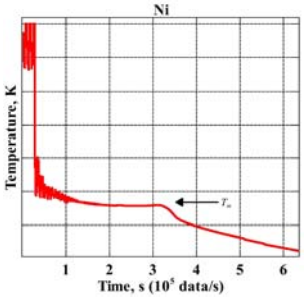

Figure 2f.: Cooling profile of Ni

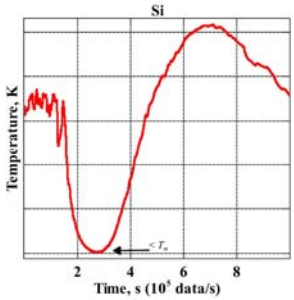

Figure 2g.: Cooling profile of Si

Figure 2h.: Si arc-melted sample, view: 1

Figure 2i.: Si arc-melted sample, view: 2

- Figs. 1a-1c show the custom-designed arc-melting setup
- Fig. 1c depicts the pyrometer position during the cooling profile recording in the current work
- The average cooling rate of the arc-melting setup is ≈100 K/s
- Figs. 2a-2g portray the cooling profile of different elements (Mo, Ta, Nb, Ti, Zr, Ni, and Si)
- Figs. 2h-2i display the protrusion on the Si surface that grown against the gravity
- Figs. 2a-2b show the cooling profiles of Mo, and Ta, which are different from other elements. The Circle denotes the region in the Mo, and Ta cooling profile.
- Mo, Ta cooling profiles (figs. 2a-2b) are similar with a pause for a few micro-second after recalescence followed by solidification at a lesser temperature.
- The cooling profile of other elements (figs. 2c-2f) are similar and usual.
- Fig. 2g shows the cooling profiles of Si.
- Si cooling profile (fig.2g) is unique; the temperature goes below the melting point and rises much above the melting point.
- The observation of the growth of few protrusions at the top Si surface against the gravity is interesting to report.

Summary and Outlook:

1. The current poster reports the cooling profiles of a different element using a pyrometer with t_{95} of 10 µs.
2. There are several exciting things to explore (e.g., cooling curves as a function of emissivity, reason, and theory for Mo, Ta cooling profile behaviour).

References: **1.** *V. B. Rajkumar et al., Int. J. Refract. Hard Met., 93 (2020) no. 105335*