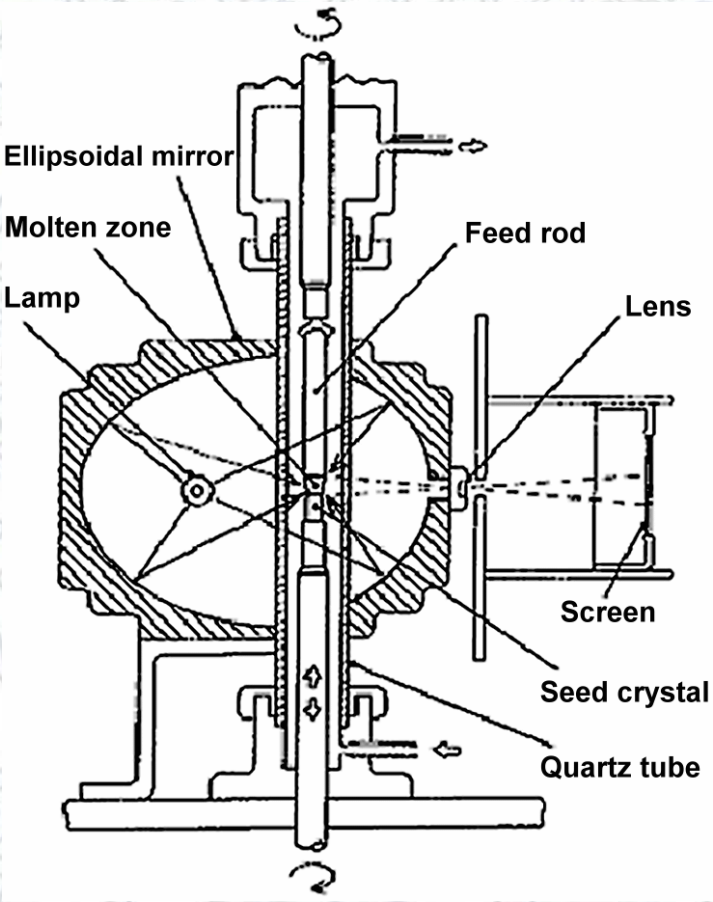
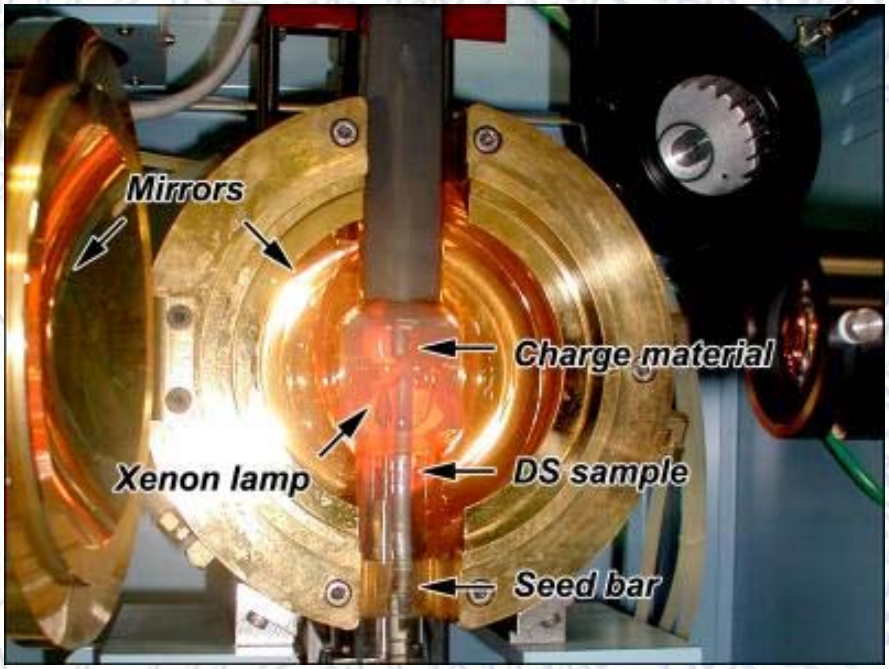
High-temperature Optical-floating-zone Furnace

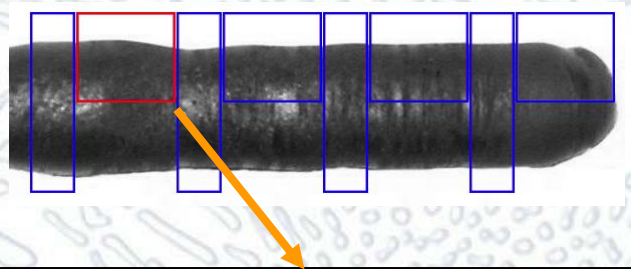




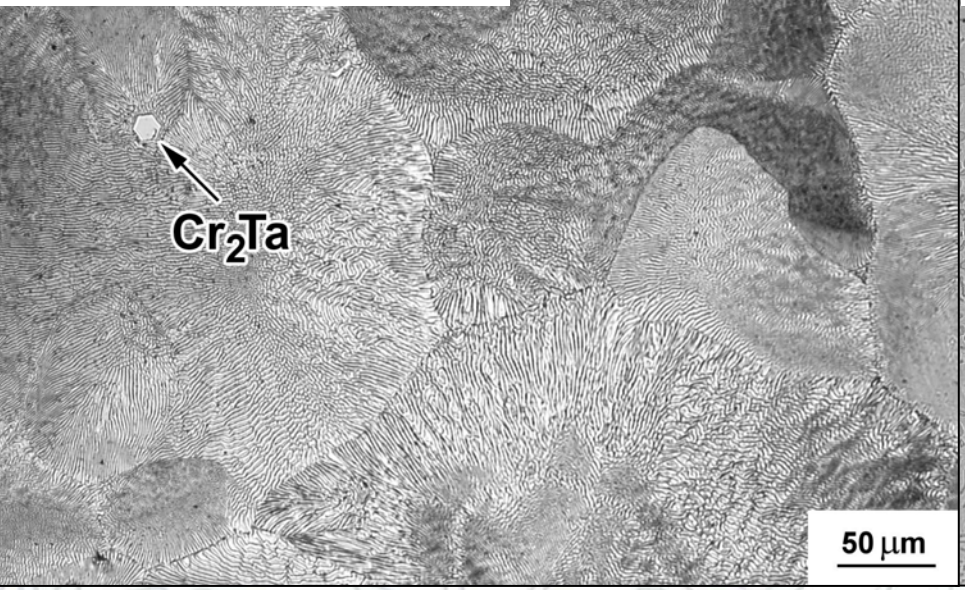
Light beams from the Xenon lamp were reflected by the mirrors and then focused on the bar sample to form a molten zone, and the mechanical system provided a downward movement of the sample and the seed bar to move the remelted zone along the length direction of the specimen. Thus, a directionally-solidified (DS) microstructure was obtained. In addition, a rotation movement was incorporated to improve the microstructural homogeneity during directional solidification.

Comparison of microstructures of Cr-Ta alloys before and after DS

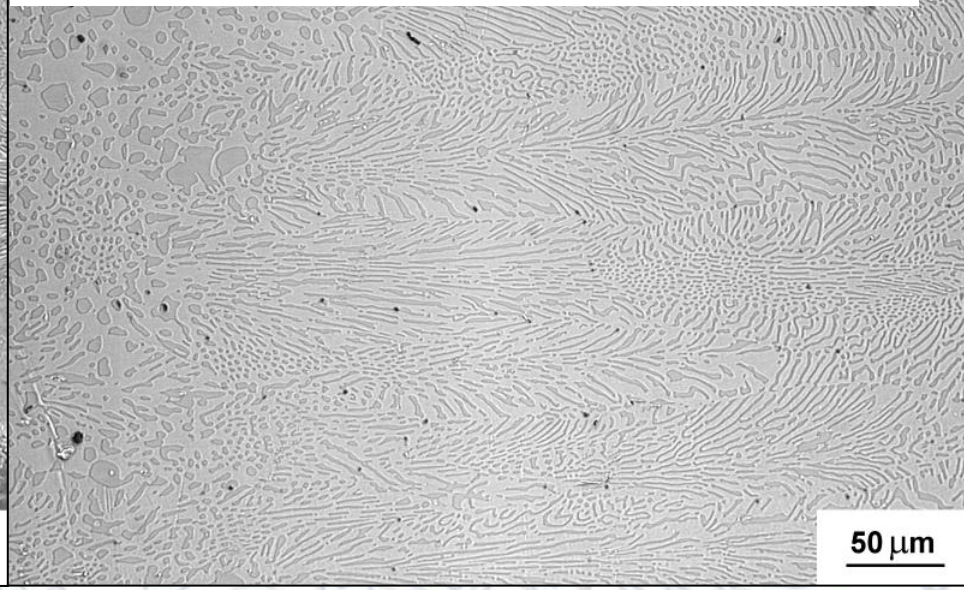
A fine lamellar structure in the drop-cast eutectic Cr-Ta sample was observed. However, the microstructures in the DS sample had a cellular feature, indicating the instability of the liquid/solid interface during the growth process.



Cr-9.71 at.% Ta alloy
Drop-cast condition
Virtually full eutectic structure



Cr-9.60 at.% Ta alloy, DS condition, longitudinal section
Growth speed 40 mm/hr., rotation rate 20 rpm
Growth length ~10 mm, Cellular structure observed.



Summary

Objectives of the present project:

1. To investigate the formation of a well-aligned lamellar structure in the Cr-based alloys reinforced by the Cr_2Ta Laves phase,
2. To elucidate the feasibility of employing the Cr-based alloy with a lamellar structure in the ultra-high temperature applications, and
3. To develop a possible low-cost process for industry-scale production of this advanced alloy.

Technical issues to overcome:

1. The evaporation of Cr at the high processing temperatures leads to fluctuation in the composition of the alloys.
2. The ultra-high temperature of the DS processing with the optical-floating-zone furnace prevents a direct measurement of the temperature, which is a great obstacle to the process monitoring and controlling.
3. Impurity contamination could occur due to the multiple processes and the high temperature.