IAF MICROGRAVITY SCIENCES AND PROCESSES SYMPOSIUM (A2)
Microgravity Sciences on board of Space stations (6)

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THE FUNCTIONALITY AND UTILIZATION OF THE CONTAINERLESS MATERIAL RACK ON THE CHINA SPACE STATION

Abstract

The Containerless Material Rack (CMR) on the China Space Station (CSS) was launched with the Tianhe core module in April 2021. Over the past three years, it has successfully debugged and validated key functions of the facility, including sample release, electrostatic sample control, high-temperature laser heating, and the measurement of high-temperature thermal properties in microgravity conditions. The facility can melt samples with melting points near 3000K and cool them at various degrees of undercooling to obtain different metastable phases. It employs semiconductor and oxide lasers for melting both high-temperature metal and inorganic non-metallic materials, with the semiconductor laser's maximum output power reaching 300W. Containerless experiments can be conducted in a vacuum of 10-3 Pa and at conditions of 3 atm under argon gas. After astronauts install the sample box into the facility, all experimental operations are remotely controlled from the ground. A single sample box can contain 29 samples, each approximately 3 mm in diameter. More than ten scientific teams have completed their orbital experiments with the CMR, and the returned sample boxes have been analyzed on Earth. The research

encompasses metal materials such as metallic glass and superalloys for hyperspace applications, focusing on microgravity's effects on their structure. Additionally, non-metal materials including high-functional glass, biomaterials, and planetary oxide materials were studied to examine microgravity's impact on the formation of metastable phases. The conference will present some intriguing results obtained from these studies.