# A CHALLENGE TO LIQUID PHASE SINTERING CONCEPTS

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## ABSTRACT

Recent experimental results from liquid phase sintered tungsten heavy alloys, conducted both on a space shuttle flight and on Earth, pose many challenges to existing sintering theories. In depth theoretical analyses on both gravity affected microstructural evolution and microgravity induced microstructural anomalies provide a better understanding of liquid phase sintering. This study includes scanning electron microscopy observations and numerical calculations of particle agglomeration. A major finding is that Young's equation ($\gamma_{sv}=\gamma_{sl}+\gamma_{lv}\cos\theta$) is not applicable in general. Theoretical and experimental results are compared for several cases of interest in liquid phase sintering such as grain settling, distortion, grain growth, particle agglomeration, wetting, and solid-liquid-vapor equilibrium.

## INTRODUCTION

Liquid phase sintering (LPS) is widely used for the fabrication of high performance materials; however, problems still remain. One is separation of the solid and liquid due to gravity. Another is microstructural gradients in grain size, grain shape and solid volume fraction in the direction of gravity. These problems have been well documented in liquid phase sintered tungsten heavy alloys [1-4], but the mechanisms responsible for the problems are still unknown. Access to the low-gravity environment of Earth orbit provides a unique opportunity to study liquid phase sintering without separation, settling, or other gravity-induced complications. The results will increase our understanding of the LPS process and help introduce new industrial applications, and allow scientists to examine more fundamental principals of physical metallurgy.

Recent microgravity LPS experiments of sintering tungsten heavy alloys, conducted during the Spacelab J mission of September 1992, revealed many unexpected sintering patterns under microgravity conditions. The results pose many challenges to existing liquid phase sintering theories. It is no doubt that our previous understanding concerning particle agglomeration, particle coarsening, and wetting phenomena need to be re-examined. This paper reports some unexpected