Manoj Gupta et al., J Material Sci Eng 2018, Volume 7
DOI: 10.4172/2169-0022-C4-102

5th World Congress on
SMART AND EMERGING MATERIALS
April 19-20, 2018 Dubai, UAE

Evolution of lightweight high entropy alloys for weight critical applications

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Composition (at. %)	Theoretical Density (g/cm^3)	Microhardness (HV)
$Mg_{35}Al_{33}Li_{15}Zn_7Ca_5Y_5$	2.25	237 ± 10
$Mg_{35}Al_{33}Li_{15}Zn_7Ca_5Cu_5$	2.27	267 ± 15
$Al_{35}Mg_{30}Si_{13}Zn_{10}Y_7Ca_5$	2.73	406 ± 15
$Al_{35}Li_{20}Mg_{15}Si_{10}Zn_{15}Ca_5$	2.41	316 ± 15

In search of high performance metallic alloys, high entropy alloys (HEAs) have emerged as a new class of alloy system. In traditional metal alloys, minor addition of alloying elements to the principal metal is made for property improvement. HEAs are fundamentally different from the traditional metal alloys in which they are composed of five or more principal elements with equiatomic or near equiatomic concentrations. The use of five or more elements at near equiatomic compositions contributes to high configurational entropy in HEAs which leads to the possible formation of disordered, single phase solid solution in equiatomic HEAs. Recently, research efforts have been made on the development of non-equiatomic HEAs to further explore the new alloy systems. In the current investigation, the lightweight high entropy alloys (LWHEAs) were designed based on the strategy of non-equiatomic composition, high entropy of mixing coupled with low density. A series of non-equiatomic HEAs containing light metals such as Mg, Al, Li and Si were synthesized with primary aim of reducing the density below 3 g/cc. The technique of disintegrated melt deposition (DMD) was used to synthesize the high entropy alloys. Following synthesis, characterization studies were done on the as-cast alloys. Particular emphasis was placed to examine and understand the microstructural development and resultant influence of microstructure on mechanical properties such as hardness. Given the continual demand of lightweight materials for weight critical applications such as in transportation sector, the efforts have been made to develop light weight, high performance HEAs targeting lightweight applications to mitigate greenhouse gas emissions.

References

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Recent Publications

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Biography

Manoj Gupta is a former Head of Materials Division of the Mechanical Engineering Department and Director designate of Materials Science and Engineering Initiative at NUS, Singapore. He has received his PhD (Materials Science) from University of California, Irvine, USA (1992), and Postdoctoral Research at University of Alberta, Canada (1992). He has published over 475 peer reviewed journal papers and owns two US patents. He has also co-authored five books and serves as Chief Editor and Editorial Boards of many international journals.

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