

研究论文

SiC晶须与Si₃N₄颗粒强韧MoSi₂复合材料

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摘要:

采用湿法混合和热压工艺制备了不同Si₃N_{4(p)}和SiC_(w)体积含量的MoSi₂基复合材料,研究了复合材料的显微组织、晶粒大小、硬度、断裂韧性和抗弯强度.结果表明,复合材料的晶粒比纯MoSi₂明显细化,且随着强化相添加量的增加而减小,抗弯强度和断裂韧性均大幅度提高,其中MoSi₂-20%SiC_(w)-20%Si₃N_{4(p)}复合材料具有较好的综合力学性能,断裂韧性和抗弯强度分别427 MPa和10.4 MPa·m^{1/2}.复合材料的强化机制为细晶强化和弥散强化,韧化机制为细晶韧化和裂纹偏转与分支韧化.

关键词: 复合材料 MoSi₂ Si₃N₄颗粒 SiC晶须 力学性能

MoSi₂ composites reinforced by SiC whiskers and Si₃N₄ particles

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Abstract:

MoSi₂ composites with different Si₃N_{4(p)} and SiC_(w) volume contents are prepared by means of wet mixing and heat pressing process. The morphology, grain size, hardness, fracture toughness, bending strength of the MoSi₂-Si₃N_{4(p)}/SiC_(w) composites were investigated by means of scanning electron microscope (SEM), polarizing microscopy, vickers hardness tester, and universal material testing machine in this paper. It is shown that mechanical properties of the prepared composites are much higher than that of MoSi₂, and its grain size is finer than that of MoSi₂, more over it is declined with the increasing of strengthening phases. MoSi₂-20% Si₃N_{4(p)}-20% SiC_(w) composite has better mechanical properties, and its bending strength and room fracture toughness are 427 MPa and 10.4 MPa·m^{1/2}, respectively. The strengthening mechanism of MoSi₂-Si₃N_{4(p)}/SiC_(w) composites are fine grain strengthening and dispersion strengthening, and the toughening mechanism are fine grain toughening and crack deflection toughening.

Keywords: composites MoSi₂ Si₃N₄ particle SiC whisker mechanical properties

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参考文献:

- [1] Manish Patel, J.Subramanyuam, V.V.Bhanu Prasad, Synthesis and mechanical properties of nanocrystalline MoSi₂-SiC composite, *Scripta Materialia*, 58(3), 211(2008)
- [2] ZHOU Hongming, YI Danqing, SHI Zhangzhi, Present status of the study on MoSi₂-based high temperature structural materials, *Materials Review*, 20(11), 404(2006)
- [3] (周宏明, 易丹青, 石章智, MoSi₂基高温结构材料的研究进展, *材料导报*, { \bf 20}(11), 404(2006))
- [4] G.H.Mohan, Development and characterization of SiC(f): MoSi₂-Si₃N₄(p) hybrid composites, *Materials Science and Engineering*, A261(1-2), 24(1999)
- [5] ZHANG Xiaoli, LU Zhenlin, JIN Zhihao, Preparation of a MoSi₂ -SiCp composite by reactive sintering without pressure, *Rare Metal Materials and Engineering*, 32(12), 1037(2003)
(张小立, 吕振林, 金志浩, 无压反应烧结制备MoSi₂--SiCp复相材料的制备与性能, *稀有金属材料与工程*, 32(12), 1037(2003))
- [6] MA Qin, WANG Cuixia, XUE Qunji, Structure development during mechanical slloying of Mo and Si powders, *Rare Metal Materials and Engineering*, 32(3), 170(2003)
(马勤, 王翠霞, 薛群基, 硅钼混合粉末在机械合金化过程中的结构演变, *稀有金属材料与工程*, 32(3), 170(2003))
- [7] Lan Sun, Jinsheng Pan, TiC whisker-reinforced MoSi₂ matrix composites, *Materials Letters*, 51(3), 270(2001)
- [8] Houan Zhang, Dezhi Wang, Chiping Chen, Toughing of MoSi₂ doped by La₂O₃ particles, *Materials Science and Engineering*, A345(1-2), 118(2003)
- [9] H.Inui, K.Ito, T.Nakamoto, Stacking faults on (001) and their influence on the deformation and fracture behavior of single crystals of MoSi₂-WSi₂ solid-solutions with the C11b structure, *Materials Science and Engineering*, A314(1-2), 31(2001)
- [10] Qin Ma, Yanqing Yang, Mokuang Kang, Qunji Xue, Microstructure and mechanical properties of hot-pressed MoSi₂-matrix composites reinforced with SiC and ZrO₂ particles, *Composites science and technology*, 61(7), 963(2001)
- [11] Zhiquan Guo, Magdalena Parlinska-Wojtan, Gurdial Blugan, Thomas Graule, Mike J. Reece, Jakob Kuebler, The influence of the grain boundary phase on the mechanical properties of Si₃N₄-MoSi₂ composites, *Acta Materialia*, 55(8), 2875(2007)
- [12] Zhiquan Guo, Gurdial Blugan, Thomas Graule, Mike Reece, Jakob Kuebler, The effect of different sintering additives on the electrical and oxidation properties of Si₃N₄-MoSi₂ composites, *Journal of the European Ceramic Society*, 27(5), 2153(2007)
- [13] K.Yamada, N.Kamiya, High temperature mechanical properties of Si₃N₄-MoSi₂ and Si₃N₄-SiC composites with network structures of second phases, *Materials Science and Engineering*, A261(3), 270(1999)
- [14] W.K.Robert, G.H.Mohan, Cyclic oxidation study of MoSi₂-Si₃N₄ base composites, *Materials Science and Engineering*, A261(3), 300(1999)
- [15] ZHOU Hongming, YI Danqing, Toughening effect and mechanism within thermo compression composite Si₃N₄/MoSi₂, *Materials for Mechanical Engineering*, 32(3), 23(2008)
(周宏明, 易丹青, 热压Si₃N₄/MoSi₂复合材料的强韧化效果与机制, *机械工程材料*, 32(3), 23(2008))
- [16] J.Wolfenstine, Y.L.Jeng, E.J.Lavernia, Elevated-temperature mechanical behavior of plasma-sprayed MoSi₂-SiC, *Materials Science and Engineering*, A189(1-2), 257(1999)
- [17] WANG Xuecheng, CAI Huifen, WANG Xiaotian, Analysis of morphology and structure of MoSi₂ synthesized by combustion method, *The Chinese Journal of Nonferrous Metals*, 5(2), 103(1995)
(王学成, 柴惠芬, 王笑天, 燃烧合成MoSi₂的组织结构特征分析, *中国有色金属学报*, 5(2), 103(1995))
- [18] Gang Wang, Wan Jiang, Guangzhao Bai, Si₃N₄ rod-like crystal-reinforced MoSi₂ matrix composites, *Materials Letters*, 58(3-4), 308(2004)
- [19] XiAO Jimei, *The Toughness and Toughening of Metal* (Shanghai: Shanghai Science and Technology Press, 1983)p.156
(肖纪美, *金属的韧性与韧化* (上海, 上海科学技术出版社, 1983) p.156)
- [20] ZHANG Houan, XU Jianguang, YAN Jianhui, HU Xiaoping, Preparation and properties of MoSi₂ and MoSi₂- based composites (Beijing, National Defence Industry Press, 2007) p.45
(张厚安, 许剑光, 颜建辉, 胡小平, *二硅化钼及其复合材料的制备与性能* (北京, 国防工业出版社, 2007) p.45)
- [21] MA Qin, YANG Yanqing, KANG Mokuang, Study of K_{1c} values of HP MoSi₂ matrix composite estimated by indentation method, *Rare Metal Materials and Engineering*, 25(2), 30(1996)
(马勤, 杨延清, 康沫狂, 压痕法测定热压MoSi₂基复合材料K_{1c}值的研究, *稀有金属材料与工程*, 25(2), 30(1996))

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1. 田晓滨;赵晓鹏;周本谦.短纤维增强复合材料的仿生模型—I 哑铃状短纤维增强复合材料的应力分析[J]. 材

料研究学报, 1994,30(16): 180-186

2. 岳广全 戴福洪 杜善义 张博明.热固性复合材料加筋壁板三维固化模拟[J]. 材料研究学报, 2010,26(05): 467-471
 3. 秦孝华; 范存淦; 韩维新; 戎利建; 李依依 .液态机械搅拌法制备陶瓷颗粒增强铝基复合材料[J]. 材料研究学报, 2002,38(8): 885-887
 4. 刘希从;魏克泰.Nicalon SiC/Al复合材料中的界面反应[J]. 材料研究学报, 1988,24(2): 183-188
 5. 姜文标;刘友鹏;舒光冀.铝液对石墨润湿过程的研究[J]. 材料研究学报, 1988,24(2): 214-217
 6. 任志锋;张承甫.共晶自生复合材料的晶形转变[J]. 材料研究学报, 1988,24(4): 365-367
 7. 郭树启;韩圭焕;姚忠凯.SiC_w/Al复合材料的微观结构与性能[J]. 材料研究学报, 1988,24(6): 499-504
 8. 曹利;蒋持平;姚忠凯;雷廷权.碳化硅晶须增强铝复合材料的断裂研究[J]. 材料研究学报, 1989,25(3): 113-118
 9. 梁民宪;夏非.TiB₂-B₄C陶瓷复合材料的微观组织和机械性能[J]. 材料研究学报, 1989,25(3): 107-112
 10. 张劲松;夏非;罗川;曹丽华;赵宽放;胡宛平.ZTA-SiC_w的显微结构与断裂特征[J]. 材料研究学报, 1989,25(6): 136-142
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