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New progress of spark plasma sintering: Diffusion behavior, densification mechanism and fabrication of new-structure metallic materials

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Spark plasma sintering (SPS) couples an electric field induced by a pulsed electric current and thus a temperature field with a pressure field. Considering specific physicochemical mechanisms of accelerating atomic diffusion and governing microstructure evolution, it can be utilized as effective approaches for material bonding, consolidating metallic powders, and fabricating high-performance bulk alloys, etc. In this presentation, the aforementioned three aspects of SPS in our group would be reviewed systematically. First, we derived the reaction diffusion rate coefficient of Ti-Cu diffusion couples under isothermal heat treatment of SPS, which is at least two times higher than the corresponding ones determined under conventional annealing. This work substantiates, for the first time, the argument that SPS accelerates atomic diffusion compared with conventional annealing. Second, we proposed the formulation of a factor, f, that when applied together with the activation energy for viscous flow (Q), can be used to provide important insight into the densification mechanism that are active during powder sintering for Ti-6Al-4V alloy and pure Ti. The higher f and Q for the atomized powders determine the higher and lower relative density compared to the milled counterparts, respectively. Third, SPS coupled with semi-solid sintering of amorphous powder was proposed as a novel approach to fabricate high-strength bimodal alloys with ultrafine lamellar eutectic structure or nano- or ultrafine matrix surrounding micron-sized dispersed phase, whose excellent mechanical properties exceed published values of equivalent materials. In summary, these results provide new insight into diffusion behavior, densification mechanism and fabricating new-structure metallic materials by SPS.

Biography

Chao Yang has completed his PhD from State Key Laboratory of Metastable Materials Science and Technology, Yanshan University and Postdoctoral studies from National Engineering Research Center of Near-Net-Shape Forming for Metallic Materials, South China University of Technology. He is the Vice Director of Key Laboratory (Category B) of High-Efficiency Near-Net-Shape Forming Technology and Equipment for Metallic Materials, Ministry of Education, China, Managing Director of Youth Committee of Chinese Materials Research Society, and a Full Member of The Minerals, Metals & Materials Society (TMS). He has published more than 90 papers in reputed journals and has been serving as an Editorial Board Member.

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