Comparative Study of Nano-composite Ti(C,N)-based Cermets by Spark Plasma Sintering and Conventional Vaccum Sintering

Wei-Hao Xiong Zai-Guo Liang Yan Lei

State Key Lab of Die & Mould Technology, Huazhong University of Science and Technology, Wuhan, P.R.China

Abstract

Ti(C,N)-based cermets have been introduced into the field of cutting tools not only for their high hardness, wear resistance, oxidation resistance, phase stability, low thermal expansion coefficient which is necessary for high temperature processing, but also for their reasonable toughness and strength. Sintering is the key influence factor in the cermets preparation process. Spark plasma sintering (SPS), as a new rapid sintering technology, has been successfully applied to fabricate ceramic composite materials, refractory compounds, nanophase materials, functionally gradient materials. Here SPS technology was used to the preparation of nano-composite Ti(C,N)-based cermets. OM, SEM, etc were used to analyze the porosity, microstructure as well as rupture pattern. The mechanical properties of Ti(C,N)-based cermets produced in different conditions were compared. The results indicated: (1) By directly elevating of temperature to 1250℃ and holding for 8min cermets material can obtain better performance; (2)Besides the common microstructure of black core/white rim, white core/black rim also existed, which resulted from the existence of nano-powders which changed the evolution of microstructure; (3) The fracture mainly originated from pores and coarse hardphase, the main fracture mode was intergranular fracture, cleavage fracture and transgranular fracture also existed. Compared with the classical vacuum sintering(VS) the results show that (1) the shrinkage process occurred mainly in the range of 1000℃ to 1300℃ during the VS process and only 0.2% linear shrinkage ratio appeared below 800℃, whereas during the SPS process 60% dimensional change occurred below 800^0C as a result of the pressure action; (2)It is difficult to obtain fully dense Ti(C,N)-based cermets by SPS due to a lot of pores and uncombined carbon, and for this reason the mechanical properties of sintered samples by SPS are inferior to VS; (3) The microstructures of sintered samples by SPS are white core/grey shell, some even haven't typical black core/grey shell microstructures, whereas by VS show typical black core/grey shell structure.