

기계적합금화와 방전플라즈마소결 방법에 의한 Ti-Cu계  
벌크 비정질 재료의 제조

**Fabrication of Ti-Cu-Ni-Sn bulk metallic glasses by consolidation of  
mechanically alloyed powders**

울산대학교 Thi Hoang Oanh Nguyen\*, 최벽파, 권대환, 김진천, 김지순, 권영순

Keywords: Ti-based alloys, bulk metallic glass, mechanical alloying, spark-plasma sintering

Ti-based bulk metallic glasses and glassy composites have attracted great attention as potential candidates for structural applications, as they show compressive strength up to more than 2000 MPa. Recently, powder metallurgical processing techniques for producing bulk amorphous alloys and amorphous-crystalline composites have been explored to overcome size limitation of bulk samples and achieve higher shape forming flexibility. This work presents results on the characterization of amorphous Ti-Cu-Ni-Sn powders prepared by mechanical alloying and of bulk samples fabricated by powder consolidation. Powder mixtures of Ti<sub>50</sub>Cu<sub>25</sub>Ni<sub>20</sub>Sn<sub>5</sub> composition were mechanically alloyed for various time in a high-energy planetary ball-mill (AGO-2) under protective Ar atmosphere. Milling for 20 h at 300 rpm led to a fully amorphous structure, as confirmed by 3d AP and TEM analyses. DSC analyses revealed glass transition at 676 K and primary crystallization at 736 K, comparable to values, which have been measured for rapidly quenched samples. Spark-plasma sintering (SPS) was applied for powder consolidation, choosing a pressure of 500 MPa and a temperature within the super-cooled liquid region. The resulting bulk samples revealed full density. However, partial crystallization of the material due to overheating during SPS was detected by means of XRD. In addition, a chemical decomposition could be detected by 3D AP.