ABSTRACT

This dissertation presents the zinc recycling of tool grade cemented tungsten scrap material generated during commercial production at Pilot Tools Pty Ltd (South Africa), production of powders and alloys from the zinc recycled materials, and evaluation of the properties of the recycled and un-recycled powders and alloys. Tool grade cemented tungsten carbide inserts were subjected to the zinc recycled process under controlled conditions. Tungsten carbide, cubic (TiC, TaC, NbC, TiCN) carbides and Co were recovered from the recycled scrap material. Two recycled alloys, R and RA, and two un-recycled alloys NS and N were produced following the conventional powder metallurgy route. Alloy R was made from 100 % zinc recycled powder with stoichiometric adjustment of C only, and alloy RA was made from 100% zinc recycled powder with stoichiometric adjustment of C and Co. Alloy N was produced under the same conditions as the recycled alloys R and RA, while alloy NS was produced at commercial level at Pilot Tools Pty Ltd (South Africa) using un-recycled powders. The alloy properties were evaluated following standard procedures for hardmetals. When the zinc recycled material was mechanically disintegrated, about 70 % of the recycled material was recovered as fine powder, while 30% was recovered as coarse oversize particles. The oversize particles were quite tough due to a high Co content, and it was difficult to disintegrate them through milling or repeated zinc recycling. The recycled powders took twice as much time to mill to the desired size as the new un-recycled powders, and had predominantly angular particles, while the new powders had smaller more rounded particles. A cubic free layer (CFL) was formed in all the alloys during sintering, although the recycled alloys R and RA had a narrower CFL compared to the new alloys NS and N. The recycled alloys R and RA had carbide grain size, carbide contiguity, binder mean free path, hardness, fracture toughness and wear rate which were generally within the same ranges as the new un-recycled alloys.