X-Ray analysis by Williamson-Hall and stereological analysis of mechanically alloyed Cu-Zr-B alloys

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Ternary Cu-2.71Zr-2.27B (wt.%) alloys were fabricated using powder metallurgy, i.e., mechanical alloying followed by cold pressing and sintering. Influence of the mechanical alloying parameters on microstructural and morphological changes of Cu-Zr-B powder mixture was investigated using scanning electron microscopy and X-ray diffraction. Stereological analysis was employed to determine changes in size and shape of copper particles during 40 hours of mechanical alloying. It was shown that with an increase in mechanical alloying time, the size of copper powder decreases. Williamson-Hall analysis was used to calculate crystallite sizes (D, nm), lattice parameter (nm), lattice strain (ε, %), and dislocation density (ρ, m^{-2}). It was shown that with increasing mechanical alloying time, lattice parameter as well as lattice strain both increases. Particles undergo high forces through ball-particle-ball and wall-particle-ball collisions during mechanical alloying. These collisions induce accumulation of dislocations in copper matrix and a decreasing in its crystallite size due to dominant plastic deformation mechanisms. Dislocation densities reach its maximum value at around 30 hours of mechanical alloying, after which they decrease owing to the recrystallization of copper matrix.