The objective of the work is to synthesize and study the structural and morphological changes in nanocrystalline Fe-50%Al alloy prepared directly by mechanical alloying in a high energy rate ball mill. The phase transformations, structural and morphological changes occurring in the studied material during mechanical alloying (MA) were investigated by X-ray diffraction (XRD) and Scanning electron Microscopy. Fig. 1 shows the morphological evolution of Fe1-xAlx alloy samples as a function of milling time. As a result of intensive fracture and cold welding during the ball milling, the structure and shape of the particles have been changed drastically. The initial shape of crystallites disappeared completely, and their structure became an amalgam of small and large irregular and angular shaped particles with wide range of sizes. During ball milling, the grain size of constituents was decreased to the nanometer range and the constituents dissolved at the nanograin boundaries, which provided the strong conditions for the solid-state synthesis reaction. This phenomenon is a result of the existence of a balance between the fracture and re-welding processes. The formation of FeAl intermetallic alloy from elemental Fe and Al powders appears to be composed of two steps: progressive refinement of Fe and Al grains within the sandwich type microstructure, followed by FeAl formation, presumably at the interfaces between Fe and Al grains. From SEM images, it is clear that the iron and aluminium elemental distributions are closely correlated indicating that the two elements are completely alloyed and the FeAl solid solution is formed. These results are very consistent with the XRD analysis.
Fig. 1: SEM micrographs of Fe1-xAlx alloy as a function of milling time.