Synthesis of an aluminium–copper nanocomposite by high-pressure torsion

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Introduction:
Although a number of SPD processing techniques is now available, high-pressure torsion (HPT) is an especially attractive, because it leads to exceptional grain refinement. It was widely used to process various metals and their alloys. Recently, a new approach was set to fabricate a metal matrix nanocomposite (MMNC) by HPT processing two or more commercial metal disks. This investigation was initiated to evaluate the potential of HPT process to synthesis of new Al-Cu MMNC.

Methods:
To this end, disks of commercial Al-1050 and Cu99.99% alloys were stacked together and then processed by HPT through 20, 50 and 200 turns at room temperature to investigate the synthesis of an Al–Cu alloy system. The microstructure was studied with the use of Scanning electron microscopy (SEM) and transmission electron microscopy (TEM). Mechanical properties were evaluated in microhardness and tensile tests.

Results:
The SEM observations showed the formation of an multi-nano-layered structure in the whole volume of the disks. Further investigations with the use TEM revealed that each nano-layer is built of nano-grains having sizes of about 20 nm. XRD and selected area electron diffraction (SAED) analysis confirmed the formation of intermetallic $CuAl_2$ and Cu_9Al_4 phases in the layered structures. The experiments also showed a significant improvement in microhardness and tensile properties when compared to both Al-1050 and Cu99.99% alloys in initial state and after HPT processing.

Conclusions:
The results demonstrate that HPT offers a great opportunity to produce novel nanostructured Al-Cu metal matrix composites with unique mechanical properties.
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