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Mechanical alloying of metal matrix composites reinforced by quasicrystals

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A1(Ni,Ti) / AUsCitoFen quasicrystal composites samples were produced by consolidation of mechanically alloyed powders. For composites preparation the quasicrystalline powder was milled together with different kinds of metallic matrices. Pure Al, AINi and AITi were taken as matrix phases. AINi and AITi intermetallic phases were also preliminarily produced by mechanical alloying from pure powder components. Structure and properties of the bulk samples were studied by X-ray diffraction and electron microscopy. Compression tests were performed, relations between structure, mechanical and tribological properties of these samples and conditions of ball milling and consolidation were investigated.

Researching shows the dependencies of compression strength a of bulk composites on the milling duration and consolidation temperature. It was also observed for microhardness, increase in milling time results in a significant increasing in σ. Also increase in time of ageing under pressure results in increase of the measured magnitude. Value of σ change insignificantly with the consolidation temperature up to 300 - 400 °C. At higher temperatures, hovewer, an appreciable increase in σ was observed for all used milling times. The increase of σ with temperature does not proceed uniformly, a significant slump was observed at 650 °C for both studied compositions. Increase in the QC fillers content results in the increase in the compressive strength.

Researching shows the dependencies of friction coefficient, wear and contact temperature of some investigated samples on the loading applied to sample. The lowest value of friction coefficient was found for Al - 10 wt. % QC composite. Friction coefficients for full quasicrystalline sample and complicate Al/AITi/QC composites are also low. For AINi/QC and AlTi/QC composites the friction coefficient value was found to be significantly higher. Increase of applied loading does not strongly affect the friction coefficient.

Increase in the loading results in the increase in relative wear of studied samples. Good wear resistance properties were obtained for pure QC sample and also for AlTi/QC and Al/AlTi/QC composites. Al/QC and AINi/QC composites reveal very intensive wear in studied range of loadings. Temperature at friction surface increased linear with increase in loading, lowest temperature was observed for Al/AlTi/QC composite and highest was observed for Al/QC one.

The preparation of quasicrystal-reinforced metal-matrix composite materials was reported. The MA technique was used for preparation of precursor powdered composites preparation. Hot high-pressure consolidation of powders was applied for producing bulk composite samples with compact structure. QC phase in consolidated samples keep stable up to ~ 700 °C. Relation between the milling and consolidation conditions of samples and their mechanical properties shows that increase in milling time results in increase in both microhardness and compression strength, whereas increase in consolidation temperature results in the decrease in microhardness and increase in compressive strength. Relations between wear resistance and mechanical properties was observed; the, best wear resistance could be achieved by the combination of high hardness and high strength.