

Nanocomposites and nanomaterials

The strength of iron-copper-carbon nanotubes nanocomposites

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Specimens of the nanocomposite material (NCM) were produced from the following components: PMS1 Cu powder, PZ-1 iron and multiwall carbon nanotubes (MCNT). The proportions of Fe and Cu in the respective mixtures were varied as 2:1; 4:1, 6:1, 3:7, 2:8 and 1:9. MCNT were added to the Fe-Cu mixture at the amount of (0.5...3) vol.% . The source substance powders were mixed in the same proportions and treated in cycles (the cycle time was 5 minutes) in the planetary-type ball mill (acceleration – 50 g, pressure on a substance particle – 5 GPa). The obtained mixtures were pressed at the pressure of 30 GPa. Then, the compressed specimens were annealed in argon atmosphere during 30 minutes at 950 °C and rolled into (1.5...2) mm thick sheets at room temperature.

It was found that the value of σ_B depends on both the total treatment time in the planetary mill and on the components concentration in the mixtures. Thus, for M1 sheet copper (100 μm thick copper foil), $\sigma_B = (314 \pm 22)$ MPa and for a copper sheet pressed from PMS1 powder and rolled at room temperature with 80% reduction, $\sigma_B = (382 \pm 24)$ MPa, whereas for the precursor rolled from the copper powder (the optimal treatment time in the planetary mill $\tau = 20$ min), the value of $\sigma_B = (605 \pm 31)$ MPa. The strength of an iron sheet pressed from PZ-1 powder and rolled at room temperature with 80% reduction is $\sigma_B = (834 \pm 42)$ MPa, while the same value for the rolled precursors is $\sigma_B = (1020 \pm 41)$ MPa. The presence of the nanotubes in iron or copper powders does not produce any significant effect on the strength of the rolled precursors. The maximum value of $\sigma_B = (1800 \pm 40)$ MPa was obtained for NCM with Fe:Cu proportion of 4:1 and with MCNT content of 1 vol.% during the treatment time of $\tau = (60 \text{ min})$.