DIFFERENCES BETWEEN MACRO- AND NANOHARNESS OF MMC MATERIALS

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Metal matrix composite (MMC) materials are very inhomogeneous materials and their properties depend on various parameters (production process, constituents and their interfaces, etc). Macro-, micro- and nanohardness of the same material can be very different, depending on the position of indentation. Four hybrid A356/SiC_p/Gr_p composites were tested. They were produced by compocasting process using Al-Si alloy matrix (A356), silicon carbide (SiC_p) microparticles (40 μm) and graphite (Gr_p) macroparticles (200-800 μm), with additional T6 heat treatment (Fig. 1a). The amount of incorporated silicon carbide was 10 wt. %, while the amount of graphite was 1, 3 and 5 wt. % [1]. Macro hardness measurements were performed using the Vickers hardness tester with 5 kg load. Nanohardness measurements were performed using the nanoindenter with Berkovich indenter and maximum load of 5 mN (Figs. 1b and 1c). Locations of the measurement were different (Table 1). There is no correlation between macro- and nanohardness. Nanohardness measurement allowed characterization of distinct regions and analysis of the influences of single composite constituents.

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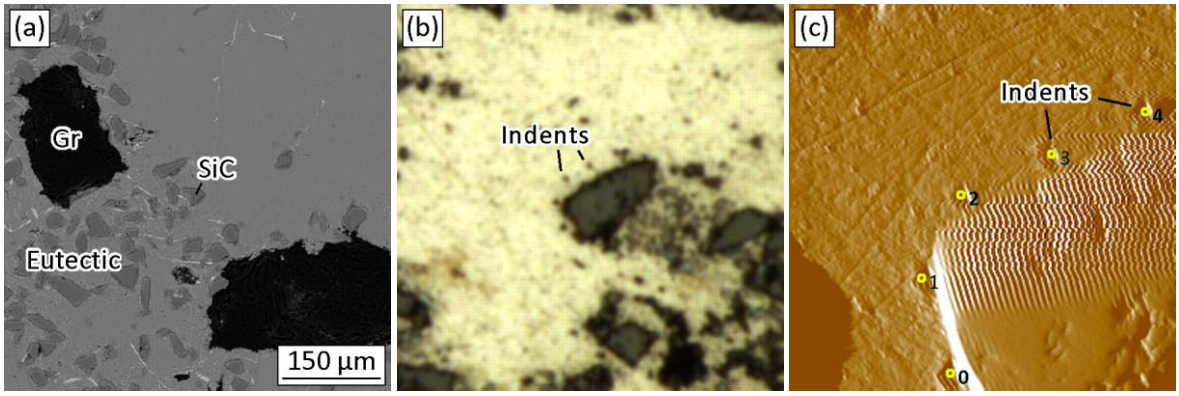

Figure 1: Hybrid composite: (a) microstructure (SEM image), (b) nanoindents (OM image) and (c) nanoindents (SPM image 40 x 40 μm)

Composite designation	Macrohardness HV5	Nanohardness H_{IT}, GPa				
		primary α phase	α phase in eutectic	α phase near SiC_p	α phase near Gr_p	α phase near SiC_p and Gr_p
A356/10SiC	68.8	0.99	1.17	1.01	–	–
A356/10SiC/1Gr	72.6	1.30	1.33	1.21	1.26	1.06
A356/10SiC/3Gr	71.4	1.10	1.18	1.34	1.26	1.11
A356/10SiC/5Gr	55.4	1.03	1.23	1.31	1.00	1.00

Table 1: Macro- and nanohardness values of tested composites

[1] I. Bobić, J. Ružić, B. Bobić, M. Babić, A. Vencl, S. Mitrović, Microstructural characterization and artificial aging of compo-casted hybrid A356/SiC_p/Gr_p composites with graphite macroparticles, Materials Science and Engineering A, 612, 2014, 7-15