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Rzeczpospolita Polska

UNIWERSYTET TECHNOLOGICZNO-HUMANISTYCZNY
im. Kazimierza Pułaskiego w Radomiu

Unia Europejska
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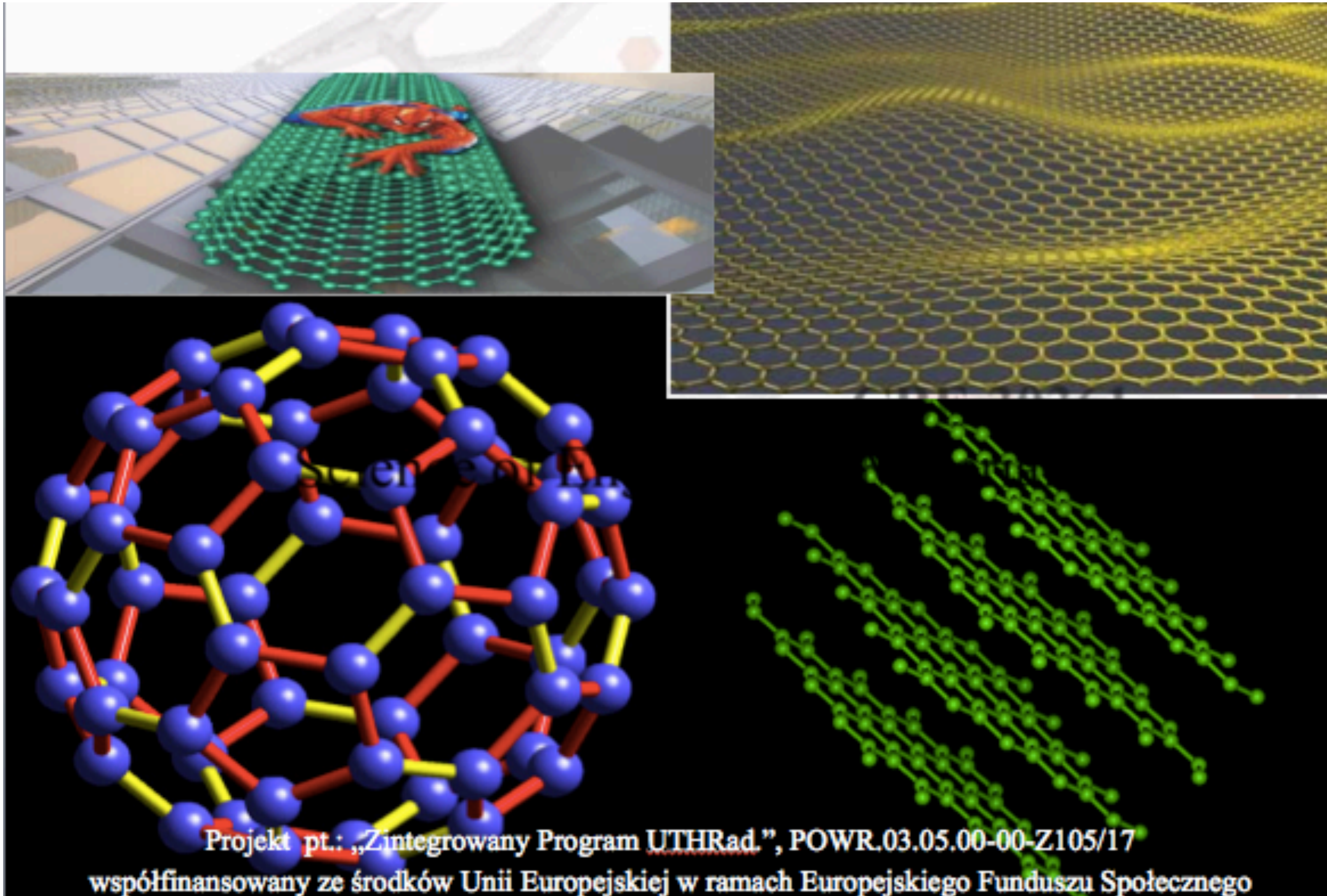

Course Number:1
Course Title: Science of Engineering Materials
Lecture №03.

Composite materials based on alumina and zirconium oxide.

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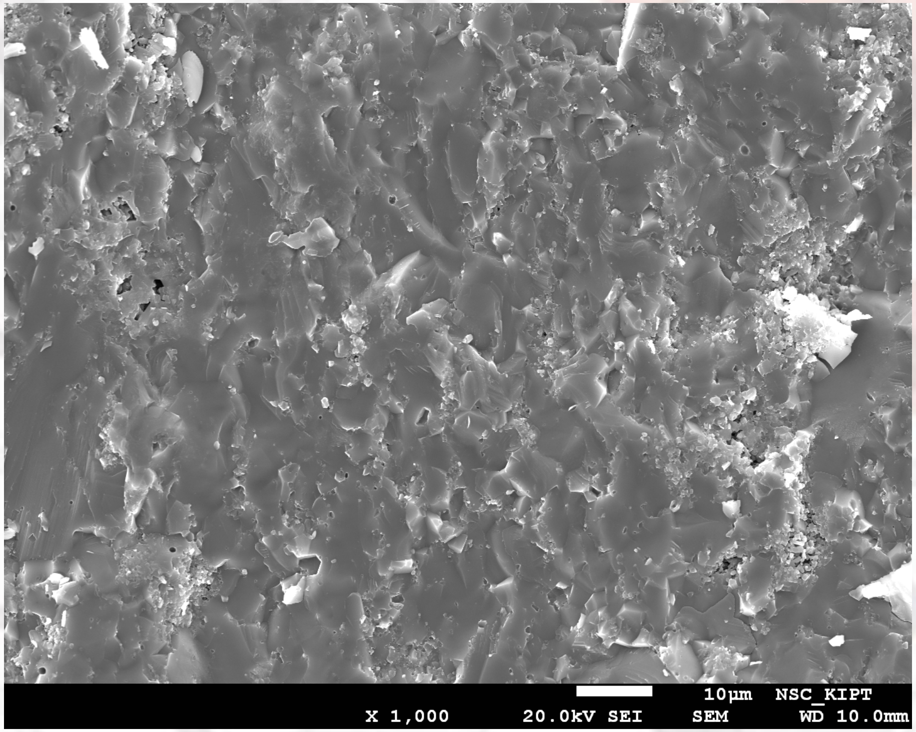
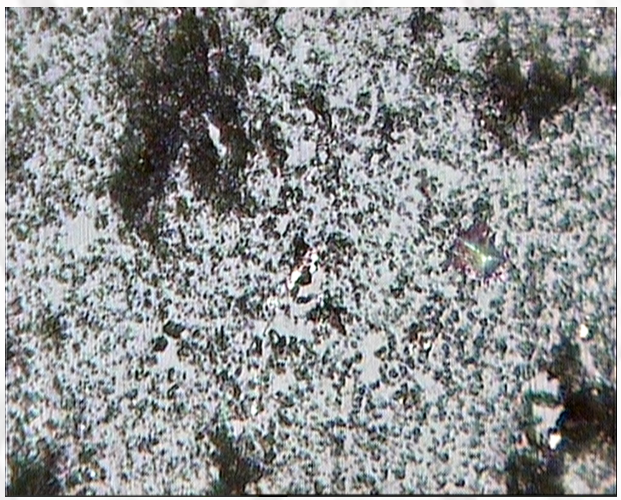
The production of composite materials with high mechanical properties by the consolidation of powder materials is associated with the solution of a number of complex problems. On the one hand, the increase in the sintering temperature promotes a more active flow of intergranular diffusion and their sintering, on the other hand it activates the formation of by-products, which negatively affects the density and hardness of the material. When choosing the optimal parameters for compaction of composite materials from nanosized powders, special attention should also be paid to their increased activity. But on the other hand, this feature of nanopowders can give a positive effect in liquid-phase sintering, reducing the temperature of formation of the eutectic mixture. Thus, the use of nanodispersed powders makes it possible to perform consolidation at lower temperatures, which lowers the reactivity of the components without affecting the diffusion processes and obtains composites with high mechanical properties.

Al_2O_3 nano structure

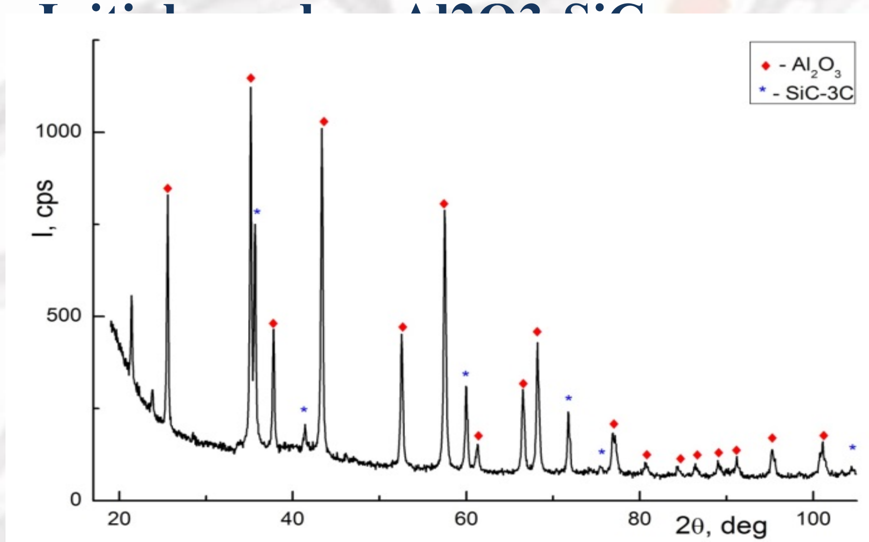


The structure of the ceramics ($(ZrO_2 + Al_2O_3)$) + 80% SiC, T = 1860 °C, τ = 4 min. (a) and traces of liquid phase separation on the mold parts (b).

Nanopowders SiC, Al_2O_3, ZrO_2 with an average size of crystallites about 50-100 nm were used as raw materials for sample production. Raman spectroscopy showed the predominance of the phase of cubic SiC (3C) with transverse and longitudinal modes and the presence of a small amount of 6H-SiC phase. Also, free carbon C is present in the composition. Based on this nano-SiC powder and additives of nanopowders of Al and Zr oxides, batch was prepared for further compaction by electroconsolidation.



Initial powder Al2O3-SiC



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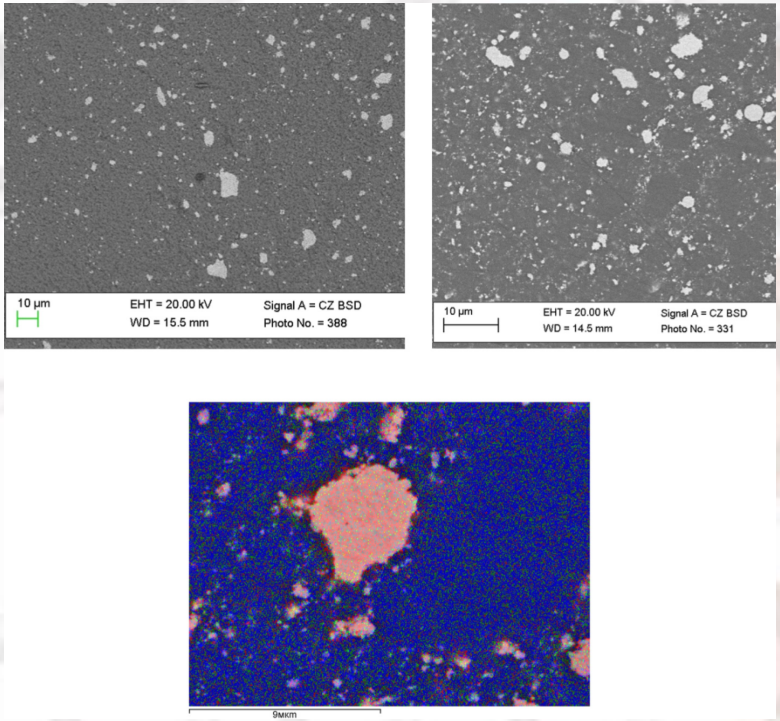
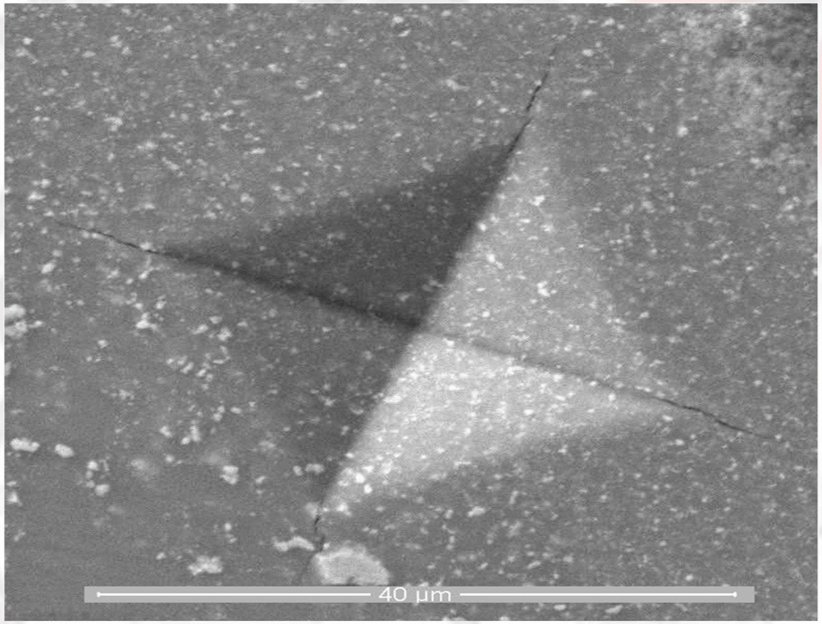
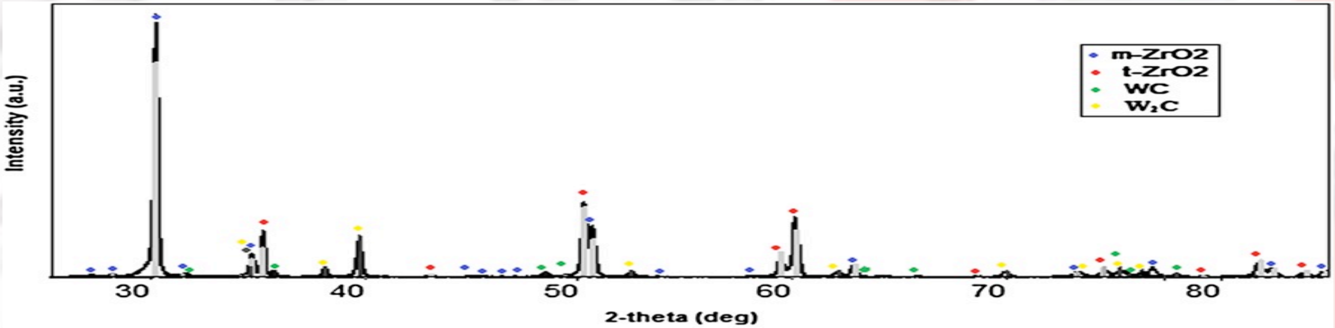


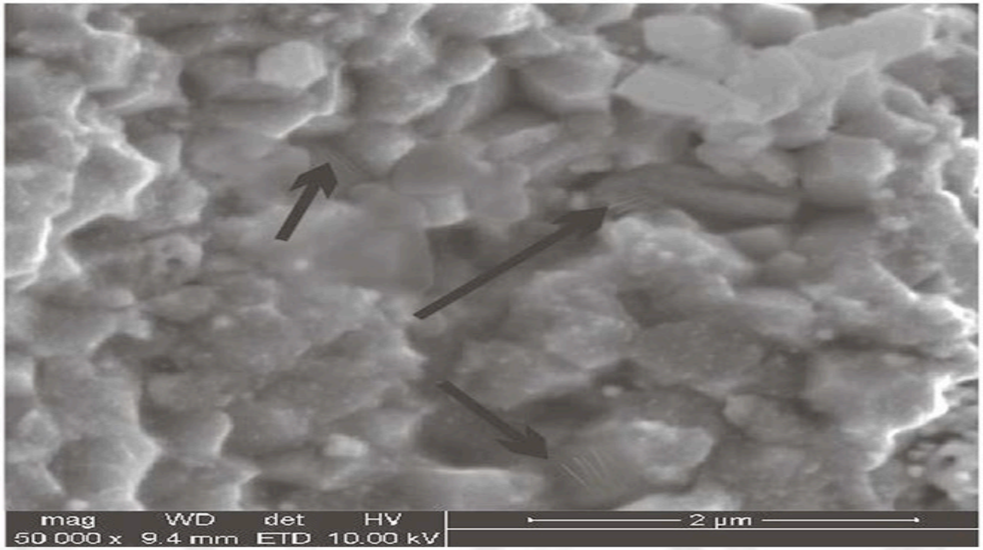
The ZrO2-WC composite microstructure in the different regimes. SEM-SE image of the composite microstructure based on ZrO2
with 10 wt.% (a) and 20 wt.% (b) WC and SEM images ZrO2-WC ceramics in regime CCL (c).
(a)



microstructure of fracture surface of WC-ZrO_2

XRD patterns (a) and SEM-SE image of microstructure (b) of fractured surfaces of the ZrO2-20 wt.% WC composites





Vickers hardness and fracture toughness of the ZrO2-20 wt.% WC composites