Jožef Stefan Institute
Ljubljana, Slovenia | K7 / Department for Nanostructured Materials

VIRTUAL SEMINAR
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Synthesis and optimization of the transition metal boride nanoparticles and their possible magnetic/hybrid composite applications

Dr. Sina Khoshsima, Jožef Stefan Institute

Metal boride nanoparticle powders have been of dire importance in recent years due to their superior properties like high melting point, chemical stability, hardness, wear resistance, and magnetic behaviour. It is crucial to design binary/ternary boride nanostructures with a specific composition by developing new synthesis strategies. This thesis reports the synthesis conditions of crystalline cobalt-metal-boron (Co-M-B (M = Fe, Ti)) based boride systems via different low temperature methods and their investigation in magnetic/hybrid composite applications. Investigations of Co-Fe-B systems as effective magnets and Co-Ti-B as effective reinforcement agents in hybrid composite production have been targeted. In the scope of the thesis, synthesis studies were carried out by inorganic molten salt and reduction at autogenic pressure techniques using the anhydrous/hydrous metal chloride and sodium borohydride powder mixtures.

The formation temperature of the ternary boride phase has been reduced to low temperatures and nanostructures have been obtained thanks to new methods developed in the study. Crystalline powders containing ternary boride phase alone or binary / ternary phases together ($CoFeB_2$, $Fe_{1,6}Co_{0,4}B$, $CoFeB_2$-FeB, CoB-FeB, CoB-TiB_2, CoB-TiB_x) were synthesized in Nano or submicron sizes and high purity using different methods and parameters. The synthesized $CoFeB_2$ powder (obtained from the anhydrous precursors) is suitable for use as a soft magnet with ferromagnetic properties and exhibits a superparamagnetic tendency after annealing and obtaining the high stability phase. The synthesized CoFeB-$CoFeB_2$ powder (obtained from the hydrous precursors) is also suitable for use as a soft magnet with ferromagnetic properties; however, after optimization of the synthesis conditions, the saturation magnetization of the obtained powders were increased 9 times. On the other hand, the synthesized CoB-TiB_2 powders were introduced as reinforcement to Ti6Al4V matrices by powder metallurgy methods and improved combination of microstructure-mechanical property was achieved.

Kindly invited.