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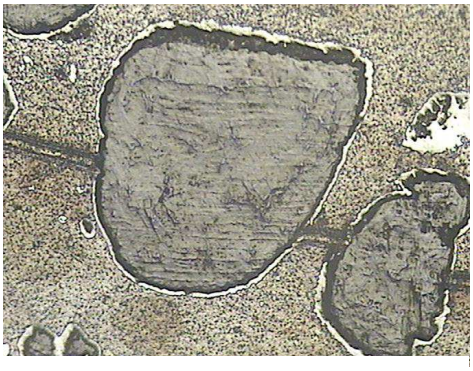
DocMASE

Education and Culture
Erasmus Mundus

DocMASE Project Proposal 2013-02

Project Title	Synthesis and characterization of metal composites with superelastic hard nano-carbon fillers
Main University and Advisor	Luleå University of Technology (Sweden) / Prof. Alexander Soldatov
Second University and Advisor	Saarland University (Germany) / Prof. Dr. Frank Mücklich
Associated Partner(s) (if applicable)	Institute of Metallurgy and Materials Science, Moscow (Russia) / Dr. Olga Chernogorova
Project Description (with **image**, if applicable)	The project team has synthesized superelastic hard phase (SHP) from fullerenes in a mixture with metal powders at a pressure of 3-8 GPa and temperature around 1000 C. The SHP exhibits a remarkable combination of high cracking resistance and hardness (H_{OP} = up to 35 GPa and HU = up to 20 GPa), and high elastic recovery (up to 95%). At the same time the material has low density (~2 g/cm^3). All these characteristics make this nanostructured carbon material an excellent filler in metal-based composites. Combination of high hardness (Fig. 1) and high elasticity makes the material very promising for low-friction and wear-resistant performance. In the course of proposed project the structure, vibrational and mechanical properties of the SHP particles will be examined at different stages of the phase transition by SEM, TEM, Raman and nanohardness methods. In order to understand the mechanism of fullerenes transformation into SHP under pressure, and finally to control and optimize physico-mechanical properties of the composites. The structure and physico-mechanical properties of the carbon particles (elastic modulus, hardness, cracking resistance, elastic recovery) will be studied as a function of high pressure-high temperature (HPHT) treatment conditions. The obtained information on structural self-organization of the carbon atoms upon the fullerene collapse under pressure will be used for optimization of the synthesis conditions for the production of super elastic hard materials, in particular, for the reinforcement of wear-resistant composites.  Fig. 1 Scratch-resistant particles of SHP in Co matrix: no trace of a nano-indenter on the particles' surface is
Previous Publications	• O. Chernogorova, E. Drozdova, I. Ovchinnikova, A. Soldatov, E. Ekimov, J. Appl. Phys. **111**, 112601 (2012). • I. Ovchinnikova, O. Chernogorova, E. Drozdova, V. P. Sirotinkin, A.V. Soldatov, A.L. Vasiliev, and E. A. Ekimov, Phys. stat. sol. (b), submitted.
References	1. R.A. Wood, M.H. Lewis, G. West, S.M. Bennington, M.G. Cain, N. Kitamura, J. Phys. Condens. Matter. **12**, 10411 (2000). 2. M. Alvarez-Murga, P. Bleuet, L. Marques, C. Lepoittevin, N. Boudet, G. Gabarino, et al., Appl. Cryst. **44**, 163 (2011). 3. O. A. Bannykh, I. N. Ovchinnikova, O. P. Chernogorova, E. I. Drozdova, V. M. Blinov and V. P. Sirotinkin, Metally **9**, 792 (2011).
Requirements of the candidates / Requirements during the doctoral programme (courses, seminars, etc.)	To receive a Swedish PhD degree the candidate in addition to 3 years of research work has to take courses and accumulate about 50-60 ECTS credits. Since this corresponds to 1 year of studies, the expected length of doctoral studies in Sweden is 4 years. About 15 of the required ECTS points will be obtained during the common activities of the DocMASE project. The fourth year will be financed by the Lulea University of Technology.