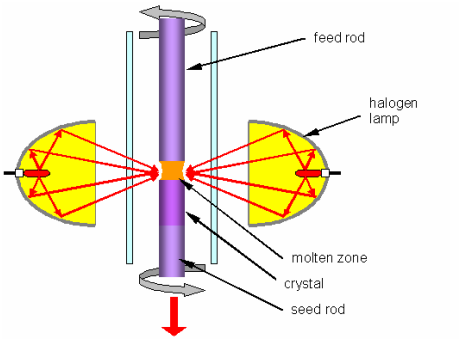

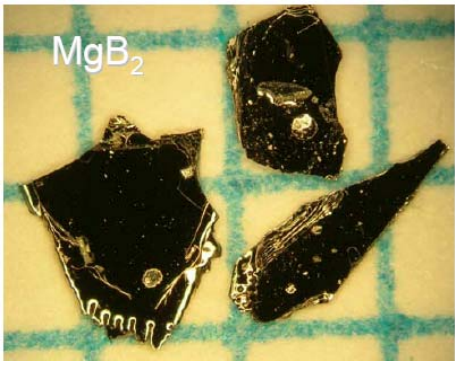

SLS Symposium on

Crystal Growth and Characterization

Tuesday, September 6, 2011

10:00 to 12:15, WBGB/019

10:00 Pulsed Laser Deposition
Philip Willmott

10:30 Crystal growth of complex oxides by Travelling Solvent Floating Zone (TSFZ) method
Kazimierz Conder and E. Pomjakushina

11:00 Coffee

11:15 FeSe-based superconductors (11, 122-type): phase diagram, synthesis and crystal growth, structural and magnetic properties
Ekaterina Pomjakushina, A. Krzton-Maziopa and K. Conder

11:45 Superconducting Materials From High Pressure Synthesis
Nikolai D. Zhigadlo, S. Katrych, J. Karpinski and B. Batlogg

Pulsed laser deposition

P. Willmott

Pulsed laser deposition (PLD) is a thin-film growth technique which has become increasingly popular as a research tool in the last two decades since it was first applied to grow heteroepitaxial thin films of superconducting YBa2Cu3O7-x in 1987. Since then, it has been used to grow thin films of many classes of materials, but has proven to be especially popular in growing films of complex metal oxides, in particular the perovskites and related layered structures.

PLD has several unique features distinguishing it from other film growth methods such as magnetron sputtering and molecular-beam epitaxy. In this presentation, I will present the most salient aspects of PLD and will also underline its limitations and drawbacks.

Crystal growth of complex oxides by Travelling Solvent Floating Zone (TSFZ) method

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In the manufacture of oxide single crystals usually methods of crystallization from high temperature solutions are applied. **T**raveling **S**olvent **F**loating **Z**one (TSFZ) method can be successfully applied for different groups of materials. In the TSFZ method a molten zone is formed and held between two solid rods by its own surface tension. For insulating materials, optical image furnaces are applied, which enable a focus of the lamp radiation into a narrow band around the material and produce very high temperature. Once a small section of the rod is melted, the molten (floating) zone is translated along the sample length by moving the material with respect to the radiation focus. Crystal material is grown on the solidifying end of the float zone. The TSFZ method has the potential advantage over the usual flux method (spontaneous solidification from the melt) as the crystal growth can be performed at one point on the temperature-composition phase diagram, and provides an opportunity to grow large single crystals even if their crystallization field is very narrow. There is no crucible necessary, which reduces the impurity level in the crystals. In the lecture principle, application region and some examples of materials (especially cuprates, manganates and cobaltates) which can be grown by this technique will be presented.

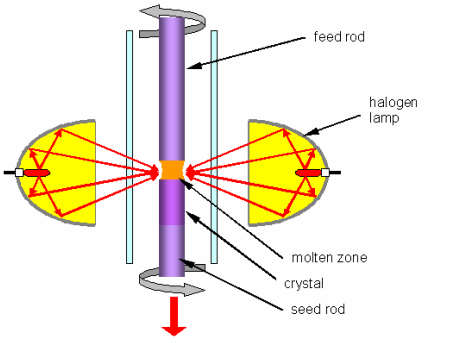

Fig.1 Principle of the Traveling Solvent Floating Zone crystallization method with application of an image furnace.

FeSe-based superconductors (11, 122-type): phase diagram, synthesis and crystal growth, structural and magnetic properties

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As it was observed previously in the cuprates, the recently discovered iron-based superconductors exhibit interplay between magnetism and superconductivity suggesting the possible occurrence of unconventional superconducting states. Among iron-based superconductors FeSe has the simplest structure with layers in which Fe cations are tetrahedrally coordinated by Se. The superconducting transition temperature (T_c) was found to be only 8K, but it can be significantly increased by applying high pressure or by intercalating alkali metal into the structure between the FeSe layers [1, 2].
Large single crystals of alkali metal intercalated iron selenide ($A_y(Fe_{1-x}Se)_2$, where A=K, Rb, Cs) can be grown similar to $Fe_y(Se_{1-x}Te_x)$ using modified Bridgman method (Figure 1) by melting in the quartz ampoule the mixture of elemental A-metal, Fe and Se, or FeSe-precursor with A-metal.
I will present our recent results of crystal growth and studies of Fe-based superconductors [2-4] by macroscopic measurements and x-ray and neutron diffraction.

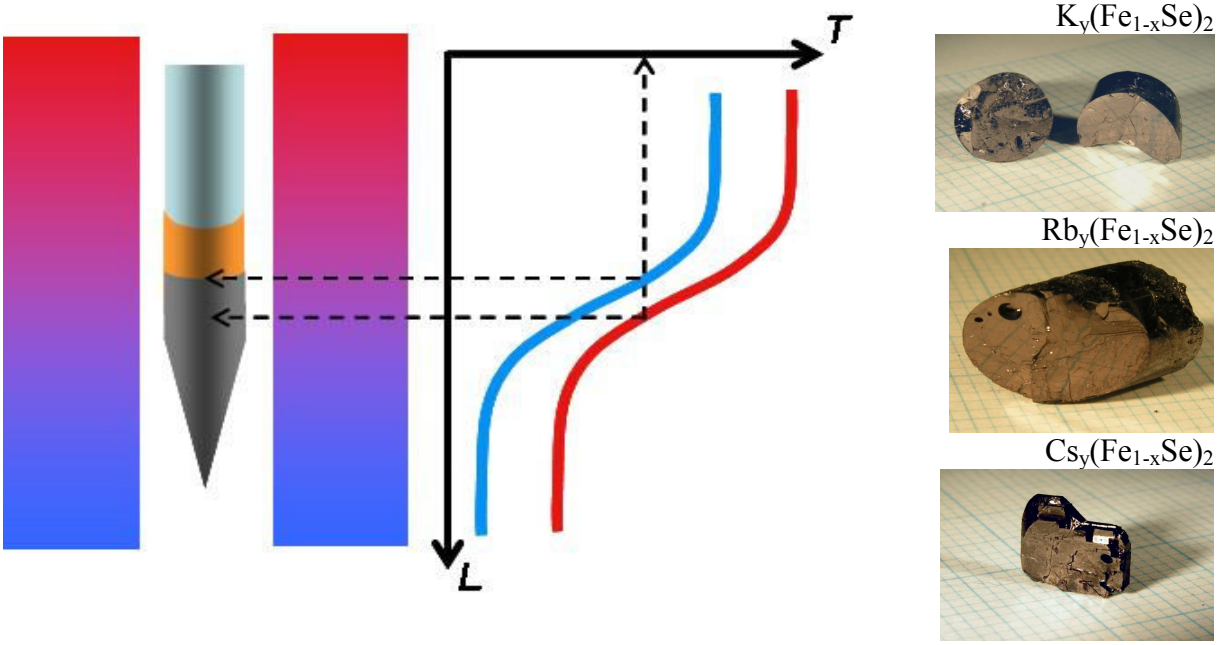

Figure 1. Principle of the modified Bridgman crystal growth method and pictures of $A_y(Fe_{1-x}Se)_2$ crystals.

[1] Jiangang Guo et al., *Phys. Rev. B* **2010,** *82*, 180520(R).
[2] A. Krzton-Maziopa et et al., *J. Phys.: Condens. Matter,* **2011**, *23*, 052203.
[3] E. Pomjakushina et al., *Phys. Rev.B,* **2009**, *80,* 024517.
[4] V. Yu. Pomjakushin et al., *Phys. Rev.B,* **2011**, *83,* 144107.

Superconducting Materials From High Pressure Synthesis

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Any performance or property of a material primary depends on the efficiency and precise nature of the synthesis and the fabrication methods. In order to get the unique properties of the materials it is desired to find a way to synthesize them with precisely controlled parameters and predictable structures. It is well known that high pressure is a ubiquitous tool in the synthesis of many new materials and high T_c superconductors in particular (Fig. 1). The main purpose of this talk is to give insight into synthesis and crystal growth of contemporary superconducting materials in which high pressure conditions can be used with success. First, I will discuss technological aspects and the major roles of high pressure and high temperature in inorganic synthesis. After that I will shortly review the multilayered structures with various type of charge reservoir blocks and different numbers of CuO_2 planes and critical temperatures (T_c`s). Finally, I will show how the application of high pressure and high temperature can affect the phase formation and crystal growth of Fe-based oxypnictide superconductors *Ln*Fe*Pn*O(F) (*Ln*: lanthanide, *Pn*: pnictogen) [1-3]. Underlying correlations and general trends between the composition, structure, magnetism, and superconductivity in these modern superconducting materials will be discussed as well [4].

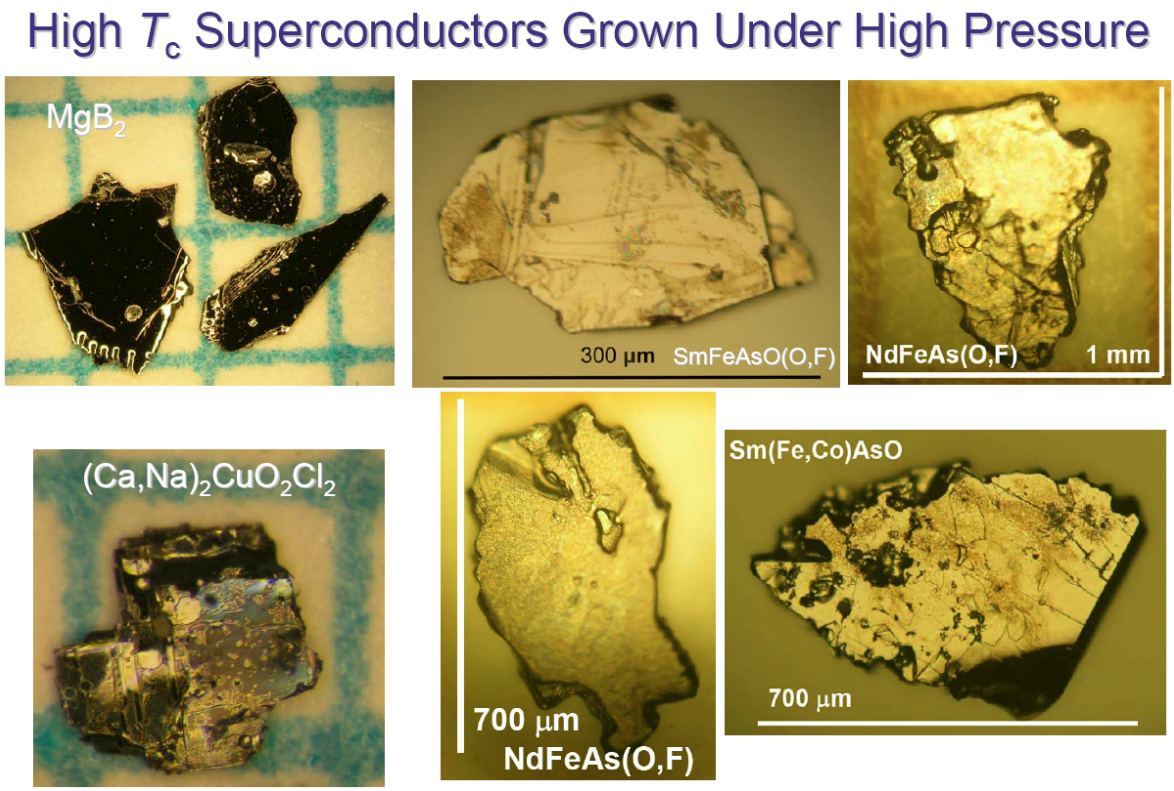

Figure 1

References:

[1] N. D. Zhigadlo et al., J. Phys.: Condens. Matter 20, 342202 (2008)
[2] J. Karpinski et al., Physica C 469, 370 (2009)
[3] N. D. Zhigadlo et al., Phys. Rev. B 82, 064517 (2010)
[4] N. D. Zhigadlo et al., arXiv: 1107.5715