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To St. Petersburg State University

Report on the dissertation presented by Veronika Burobina,
entitled "Studies of Magnetic properties in GaAs:Mn, LaSrMnO3 and YIG"

The candidate Veronika Burobina has conceived her PhD work within the research stream focused on synthesis of thin films of magnetic materials for possible application in energy technology. It is indeed true that the development of industrialized world is nowadays demanding more efficient and environmentally friendly technologies for any field of applications, as the magnetic refrigeration technology. In this respect, the candidate has addressed the magnetic properties of three different materials of potential use in such a technological mainstream, namely:

a) Mn-doped semiconducting GaAs
b) Colossal magneto-resistive $La_{0.7}Sr_{0.3}MnO_3$
c) Insulating ferrimagnetic $Y_3Fe_5O_{12}$

In the first chapter of the thesis, the candidate has addressed, mostly from theoretical point of view, a fundamental physical properties of magnetic Mn-doped GaAs semiconductor, namely the spin relaxation time. In particular, her calculation, based on experimental data extracted by Hall measurements, provides evidence that the spin relaxation time sizably increases when the concentration of donor impurities is larger than the acceptor ones. Such a result might also be useful in other field of research, such as spintronics devices.

In the second chapter of the thesis, the candidate has focused her attention on one specific physical mechanism for magnetic refrigeration. In particular, it is known that by cyclically applying a magnetic field to a ferromagnetic material, due to the magnetic alignment of its domains, the material slightly increases its own temperature. Subsequently, the removal of the magnetic field induces a cooling of the material. If the principle of such a technological tool is clear, still it is ongoing the research to identify the best material in this view. The candidate has focused her attention to a member of the family of perovskite oxides, namely the $La_{0.7}Sr_{0.3}MnO_3$ (LSMO), which shows a Curie temperature (i.e. ferromagnetic transition) close/larger than room temperature. In particular, she has investigated the LSMO properties when grown on piezoelectric substrate (PMN-PT in the present case). The main result appears the large value of the mass-specific isothermal entropy measured in LSMO films grown on PMT-PT with an external voltage applied. She has directly followed the growth of the LSMO thin films grown by Pulsed Laser Depositon (PLD). Moreover, in the thesis, the candidate has also proposed a multi-layered approach in view of improved the performances of LSMO/PMT-PT artificial multi-ferroics.

Вх. N 09/2-504 от 17.12.2019

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In the third chapter, the candidate has finally addressed the magnetic properties of insulating ferrimagnet $Y_3Fe_5O_{12}$ yttrium iron garnet (YIG). Importance of such a material is widely accepted being ferromagnetic at room temperature and characterized by insulating properties which make it extremely interesting as potential material for ferromagnetic insulating barrier in spintronics devices. As for the deposition of LSMO, also in the case of YIG films, the candidate has successfully used the Pulsed Laser Deposition to grow high quality thin films on GGG substrates. The main result has been the determination of the thickness of the magnetically-dead layer of YIG thin films and its possible origin due to Ga atomic diffusion from the substrates. The candidate also has followed the magnetic characterization of the YIG films.

In my opinion, the whole Ph.D. thesis work has been consistently focused on the control and determination of magnetic properties of several functional materials, namely the semiconducting Mn-doped GaAs, the Colossal Magneto-Resistive $La_{0.7}Sr_{0.3}MnO_3$ and the Insulating ferrimagnetic $Y_3Fe_5O_{12}$. Even though the main motivation of the present thesis work lies in the framework of magnetic materials for magnetic refrigeration technology, the obtained results go beyond this specific field of applications and might surely have impact in other research field (e.g. spintronics).

I can fairly conclude that the thesis entitled "Studies of Magnetic properties in GaAs:Mn, $LaSrMnO_3$ and YIG" by Veronika Burobina fulfills the requirement established by St. Petersburg State University and deserves to be awarded the degree of PhD in Physics and Mathematics.

With my best regards,

Trieste, December 10th, 2019

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