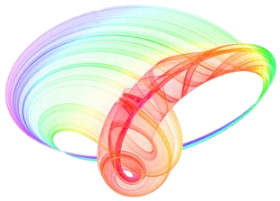
Book of abstracts



PHOTONICA2021

VIII International School and Conference on Photonics

& HEMMAGINERO workshop

23 - 27 August 2021,

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Editors

Mihailo Rabasović, Marina Lekić and Aleksandar Krmpot

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ABSTRACTS OF TUTORIAL, KEYNOTE, INVITED LECTURES, PROGRESS REPORTS AND CONTRIBUTED PAPERS

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How to create 2D magnets from non-magnetic 2D crystals

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The introduction of point defects offers manifold possibilities to induce a magnetic response in intrinsically non-magnetic two-dimensional (2D) materials. In graphene, the presence of vacancies leads to notable paramagnetism, yet no long-range magnetic ordering has been experimentally achieved due to low defect concentration. Another approach to induce magnetism in 2D crystals is to adsorb magnetic transition metal atoms. However, when deposited on graphene, transition metal atoms tend to cluster due to strong metal-metal attraction [1], making it challenging to control the shape and size of obtained nanostructures and their magnetic properties. One route to suppress the unfavorable clusterization is to attach the metal adatoms to the vacancies, acting as the trapping sites. The embedded metal atoms might carry out non-zero magnetic moments, yet the random distribution of these defects across the 2D sheet makes the long-range ordering of localized magnetic moments highly unlikely. In this lecture, we show that with the use of borophene, a 2D boron crystal recently synthesized on Ag(111) substrate, these obstacles can be overcome [2]. Borophene, unlike graphene, possesses a regular pattern of hexagonal holes which can be used as a template to grow 2D magnets when filled with Fe atoms. We show that the obtained Fe nanostructures are composed of close-packed Fe wires featuring ferromagnetism within the chain and the inter-chain antiferromagnetic coupling. Using density functional theory calculations, we extract the exchange and single-ion anisotropy constants needed to describe the magnetic properties of these systems with the classical Ising and Heisenberg models. The corresponding Monte Carlo simulations revealed finite temperature magnetic ordering, with the estimates of critical temperatures of 105 K and 30 K derived from the anisotropic Heisenberg model, for the Fe-based magnets grown above and under the borophene.

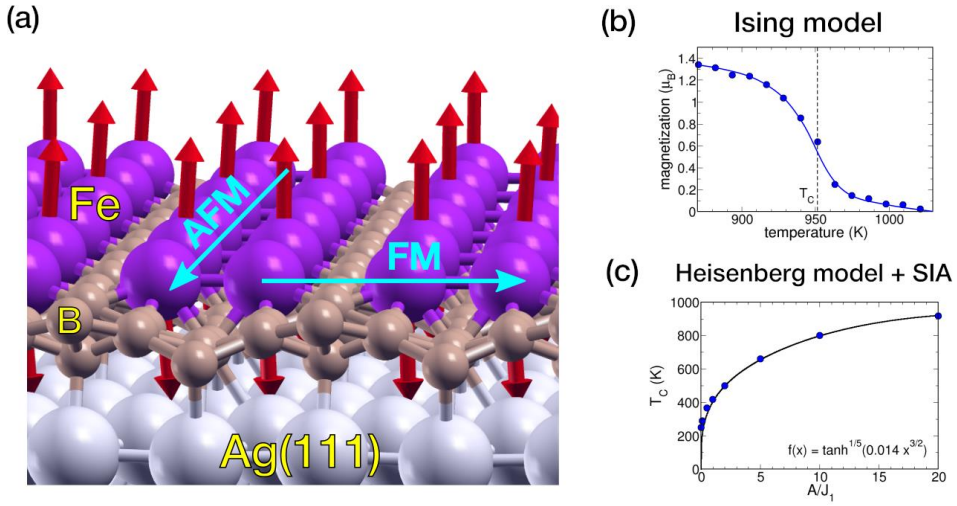

Figure 1. 2D magnet made from Fe wires grown above borophene/Ag(111) (a) and the critical temperatures obtained from Monte Carlo simulations employing Ising (b) and anisotropic Heisenberg model (c).

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