

# **SEMINARIUM Z MAGNETYZMU I NADPRZEWODNICTWA**

Uprzejmie zawiadamiamy, że w **środę**

**12 października 2022 r., o godz.10:00**

odbędzie się seminarium **on-line (link podany jest na stronie IF PAN),**

na którym

**dr Katarzyna Gas**

*(Instytut Fizyki PAN, Warszawa)*

wyłosi referat na temat:

**“Manganese in wurtzite GaN”**

Co-authors: D. Sztenkiel, P. Wiśniewski, Y.K. Edathumkandy, R. Jakiela, M. Iwinska, T. Sochacki, M. Bockowski, H. Przybylinska, D. Hommel, and M. Sawicki

The ferromagnetic form of GaN may have an enormous technological relevance due to the already dominating role of the nitride family in light industry, high-frequency, and high-power electronics. In particular, the existence of sizable piezoelectromagnetic coupling has been evidenced recently in (Ga,Mn)N [1], an effect that opens the door for realization of external electric field driven, repeatable magnetization reversal. It is, therefore, very important to verify the physics of transition metals in nitrides.

In this talk I will report on magnetic properties of Mn in GaN. I will start from bulk single crystals with Mn concentration up to  $5 \times 10^{19} \text{ cm}^{-3}$  [2]. Here Mn should assume  $\text{Mn}^{3+}$  ( $d^4$ ) configuration. Such a center is characterized by a very strong single ion magnetic anisotropy. The trigonal-symmetry surrounding and Jahn-Teller effect lead to splitting of the five lowest spin quantum levels ( $m_s = 2, -1, 0, 1, 2$ ). Around  $H = 0$  the ground state is composed mostly of  $m_s = 0$  and with the increase of magnetic field  $m_s = -1$  and  $m_s = -2$  become sequentially the lowest states, leading to a well-developed staircase-like magnetization curve at 0.5 K. The distinctive shape and positions of the magnetization steps serve to pinpoint the values of the parameters of the crystal field model. Using magnetic characterization aided by EPR results, an accurate spin counting of  $d^5$  and  $d^4$  levels is possible constituting an indispensable characterization tool for these commercially important crystals.

Next I will proceed to much concentrated epitaxial (Ga,Mn)N layers with Mn contents up to 10%. Here superexchange-mediated ferromagnetism develops at low temperatures. The magnetic anisotropy of such systems will be discussed and some possible means of its control will be presented.

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[1] D. Sztenkiel *et al.*, Nature Comm. 7, 13232 (2016).

[2] M. Bockowski *et al.*, Journal of Crystal Growth 499, 1-7 (2018).

*The lecture will be given in Polish and the slides will be in English.*

**Serdecznie zapraszamy**

**Roman Puźniak  
Andrzej Szewczyk  
Henryk Szymczak**