

Altermagnets - Key to Future Sustainable Spintronics

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Apart from the conventional ferromagnetic and antiferromagnetic ordering, recent theoretical prediction distinguished the third magnetic phase – so called “altermagnets”. These systems show properties both of the ferromagnets and the antiferromagnets simultaneously[1] - they have no external magnetization yet they still reveal some “magnetic” effect, such as anomalous Hall effect, magnetoresistance etc. A model system is an alloy Mn_5Si_3 which, however, becomes “altermagnetic” only as a thin film of a few nanometers as a result of the strain that occurs during preparation of the thin layer. However, it is theoretically predicted that if we apply large enough strain on a bulk crystal of Mn_5Si_3 , it should be possible to modify its magnetic structure and the system might even become “altermagnetic”. This project is dedicated to a study of the effect of strain on the thin films and crystals of Mn_5Si_3 . The strain will be induced by a commercial piezo-stressors [Fig.1 (a)], and its strength will be measured by kapton-based strain gauges.

In the first part of the project the student will learn how to prepare and place a sample on the piezoelectric actuators, devices that can convert applied voltage to the mechanical strain by means of a piezoelectric effect [see Fig. 1 (a)]. This structure will then be tested and optimized to achieve the maximum strain level on the sample [2]. The strain will be measured by a conventional strain gauge [Fig.1 (b)]. The gauge will be connected to a home-made Wheatstone bridge circuit that enables to measure small changes in resistance of the gauge resulting from the strain. The main goal of the project is to quantify the maximum strain achievable by the piezo-stressor in the Mn_5Si_3 sample in order to gain a comparison with the theoretical predictions for the “altermagnetic” state in this material.

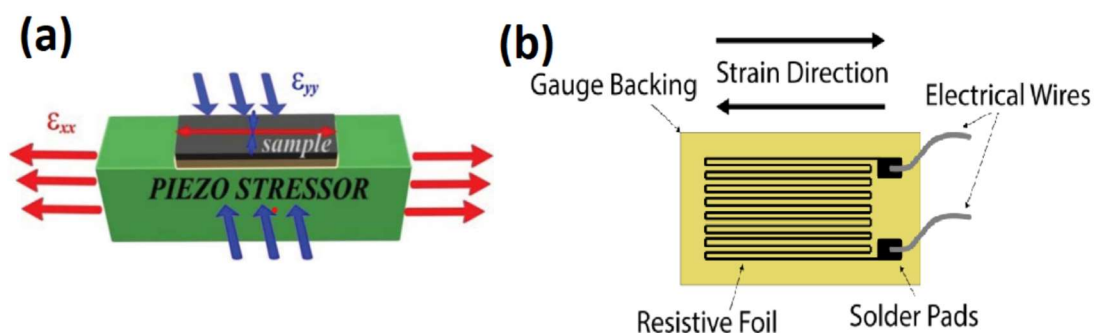


Fig. 1 (a) schematic view of a piezo actuator (b) strain gauge.

1. Šmejkal, L., J. Sinova, and T. Jungwirth, *Altermagnetism: spin-momentum locked phaseprotected by non-relativistic symmetries*. arXiv:2105.05820, 2021.
2. D. Butkovičová et al., *Critical role of the sample preparation in experiments using piezoelectric actuators inducing uniaxial or biaxial strains*, Rev. Sci. Inst. 84, 103902 (2013)