On the magnetism of the Heusler Co2FeSi influenced by adjacent iron layers investigated using DPC

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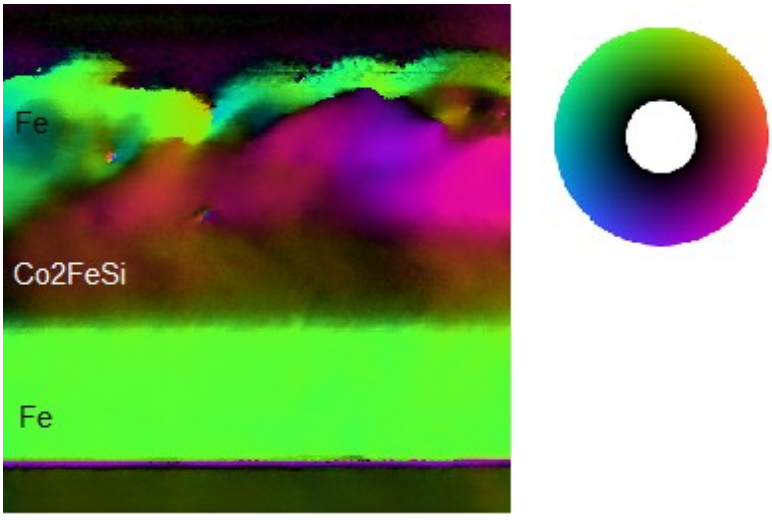
Heusler alloys play an important role in the growing field of spintronics and magnetic sensor applications. The magnetic behavior of the full Heusler Co2FeSi influenced by adjacent Fe layers in the form of a Fe/Co2Fesi/Fe sandwich has been investigated in the transmission electron microscope using differential phase contrast methods. The specimen has been created by Co-sputter deposition on MgO and a FIB lamella has been cut using a Gallium dual beam FIB.
Chemical characterization using EELS techniques results in a uniformly grown iron layer, a Co2Fesi layer with changing composition towards the 2nd iron layer with a growing amount of Fe and a falling amount of Co and a rough but chemically pure 2nd iron layer. The interfaces between iron and Heusler are not of the same quality.
Differential phase contrast (DPC) with a segmented detector and with a Medipix3 direct electron detector have been performed. The iron could be well characterized, the Co2FeSi
shows high contrasts of different types making the measurement with both DPC methods
more difficult as deflections caused by other types of contrast are also high in the Heusler and finding the beam disc on the pixelated detector data is more challenging. The results show magnetic influence of the iron reaching up to ~10nm into the Heusler. The rest of the Heusler does not follow the iron but appears to be magnetized perpendicular to the iron which can be explained by the external field of the objective lens as Co2FeSi is a soft magnetic material. With the small external field of the dimly switched on objective lens the iron layers could be switched magnetically by tilting the specimen into the field and indicing an in-plane component. Three magnetic states could be achieved: both layers in parallel in both possible directions and an antiparallel magnetized state. Also the formation of a domain wall in the iron could be observed.



(DPC result from pixelated DPC measurement using the Medipix3 detector. The layer system made of Fe/Co2FeSi/Fe on MgO is visible, the deflection of the electron beam disc is shown color-coded by direction (color wheel on the right). The deflections are caused by magnetic contrast and diffraction contrast. In the upper Fe layer a domain wall can be seen.)