Exploring new 2D halides materials for quantum devices

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The recent evolution at building quantum devices, especially quantum computers, is requiring important developments on hardware optimization with the potential to solve problems that cannot be solved by classical computers. The scaling up of the quantum processors requires improvement of the qubit's performance that stimulates investigation of alternative architectures and new pipeline of materials that also allows controlling and reducing the noise, loss and decoherence process of present devices. Among the new arquitectures and materials that are being explored as new platforms for future developments, creating heterostructures based on two-dimensional materials grows day by day, with special attention on those including magnetic semiconductors suitable for creating exchange coupling in the heterostructures with superconductors.

In this context, by combining different highly sensitive surface science technique, we are exploring the magnetic, electronic and structural properties for binary transition metal dihalides MX_2 (M=Metal cation, X=halogen anion) which theoretically exhibit promising magnetic and electronic properties. We demonstrate that these MX_2 (M=Ni, Fe, Co; X=Br, Cl) materials, that can be epitaxial grown on different substrates [1], present ferromagnetic ordering (collinear or non-collinear depending on the compound) in the limit of a single or a few atomic layers thick films, although in bulk form they are antiferromagnets. Moreover, we also probe the survival of superconductivity when these materials are in contact with a superconductor material, such as $NbSe_2$ or Al. The advantage of these materials compared to other 2D materials, such as graphene or TMDs, is that their synthesis is compatible with standard microelectronic manufacturing (lithography, resin prepattern, etc) and, therefore fabrication of devices does not require any exfoliation or stamping of the 2D flakes.

References

[1] D Bikaljević, et al. ACS nano 15 (2021), 14985-14995

Figures

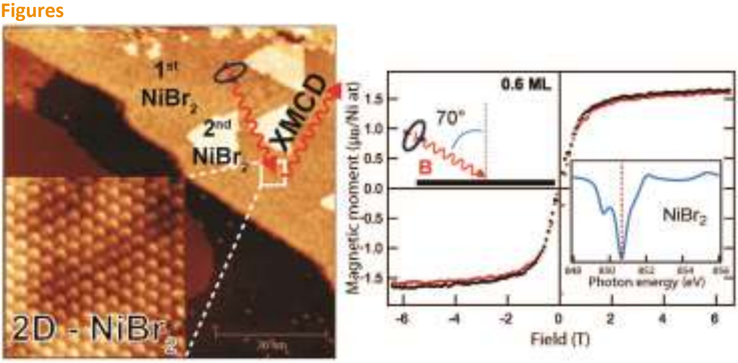

Figure 1: STM image and XMCD Magnetization loop measured for $NiBr_2$ epitaxially grown on Au(111) both measured at temperatures around 4K (XMCD magnetization loops measured for L3 Ni edge varying the magnetic field).