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Report:

Diffraction and reflectivity measurements have been performed on magnesium diboride thin films grown on, (111) MgO, c-plane sapphire and c-plane sapphire with zirconium diboride buffer layer.

The aim was to study the orientation of the MgB_2 phase with respect to the different substrates. The samples were prepared by a standard two step technique in which an high temperature annealing is needed to crystallize the superconducting phase from an amorphous PLD deposited precursor.

Reciprocal space mapping measurements revealed that films deposited on (111) MgO are c-axis oriented but no in plane orientation is present. The same analysis performed on samples grown on Al_2O_3 c-cut showed that an epitaxial interlayer of MgO between the substrate and the MgB_2 film is present, probably caused by oxygen interdiffusion from the sapphire, which is not stable at the high temperatures used for the heat treatment (900°C). The presence of the MgO layer was evidenced also by reflectivity measurements, where a superstructure was observed. In this case a single in plane orientation of the MgB_2 film has been detected, with the cell superimposed to that of MgO and rotated of 30° with respect to sapphire. Furthermore, the 101 peak of MgB_2 in the reciprocal space map resulted to be formed by two different peaks: the first, very narrow and sharp, is related to a strongly crystalline part of the sample and the other, broad and weak, suggests that also a less crystallized MgB_2 phase is present. The lattice parameters *a* and *c* calculated from the position of the two peaks are very similar to the bulk values for the narrow peak, while they are both expanded in the

less crystalline phase. Deformations of crystalline lattice such as enlarged *c* axis, seems to be responsible for the very high upper critical fields recently observed in MgB_2 thin films.

In the case of magnesium diboride grown on ZrB_2 buffer layer, the structural characterization is not trivial, because MgB_2 and ZrB_2 peaks have the same angular position. To separate the contributes of the two layers, anomalous diffraction near the absorption energy of zirconium has been performed, thus allowing to decrease the intensity of ZrB_2 reflections with respect to the MgB_2 ones. As it was expected considering the low lattice mismatch between magnesium and zirconium diborides, the same single in plane orientation of the buffer layer was found in the superconducting film, without any rotation of the cell. MgB_2 showed a smaller *a* axis and an enlarged *c* axis with respect to the bulk values. Finally, the effect of the ZrB_2 interlayer is also to avoid oxygen contamination from the substrate; in fact, any magnesium oxide layer has been observed in this sample.

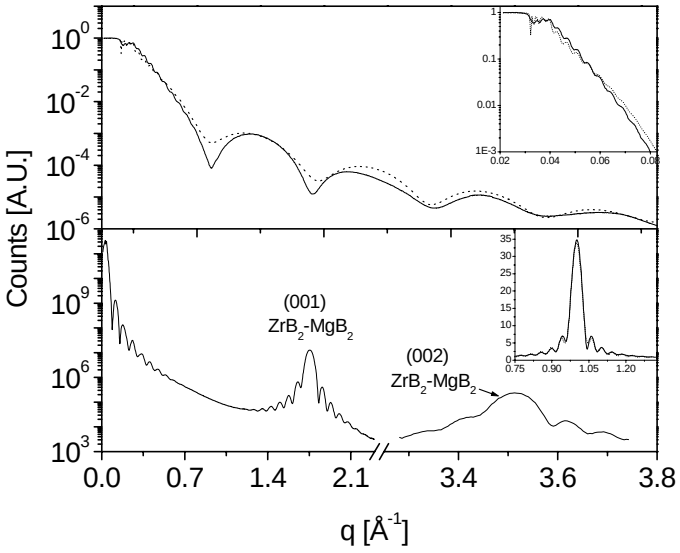

Figure 1: Upper panel: reflectivity measurement of the film (straight line) and fit (dashed line). In the inset, magnification of the low angle region, in which fringes due to MgB_2 film are visible. Lower panel: θ-2θ measurement. A fit of finite size oscillations in 001 peak (dashed line) is reported in the inset.

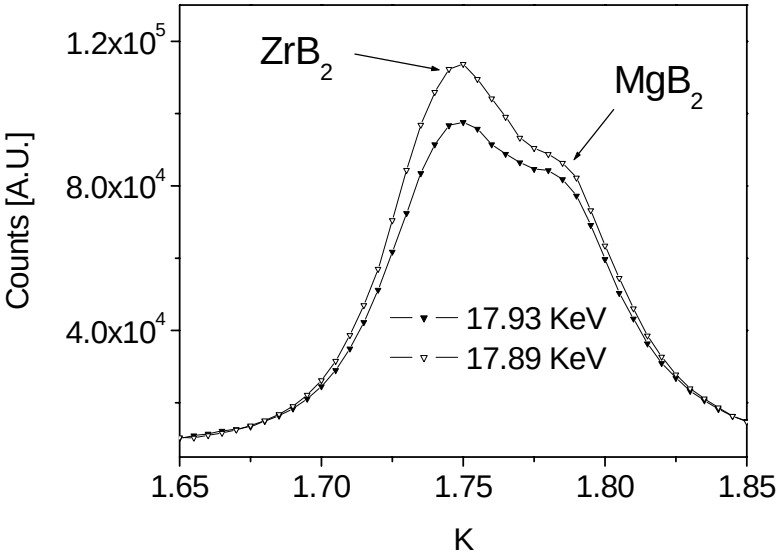

Figure 2: K scan at different energies (17.93 KeV, full symbols, and 17.89 KeV, open symbols) around a ZrB_2 peak.

Epitaxial MgB_2 thin films on ZrB_2 buffer layers: structural characterization by synchrotron radiation
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Submitted to superconducting Science and Thecnology

Structural properties of MgB_2 thin films investigated by synchrotron radiation
V. Ferrando [a], C. Tarantini [a], E. Bellingeri [a], P. Manfrinetti [b], R. Felici [c] and C. Ferdeghini [a]
Presented at INFMEETING 2004 Genova

Upper critical field up to 60 T in dirty magnesium diboride thin filmsC.Ferdeghini, V.Ferrando[a], C.Tarantini[a], D.Marré[a], M.Putti[a] , P.Manfrinetti[b], A. Pogrebnyakov X.X Xi
Will be presented at ASC Jacksonville Florida.