In addition, it has been shown that at low temperature (4K) the maximum MR was found about 90% for the PC-LT. Moreover, MR was found to be related more to the number of "bad" GB in the electrical path than to the size of the grains.

At this point one question arises: Could be GB zones with different magnetic coupling?. This is difficult to answer because standard magnetisation measurements as VSM or Squid are bulk measurements and the magnetisation extracted from these measurements do not always reflect the magnetic state of the films (additional signal coming from substrate impurities, experimental set-up, estimated thin film volume..).

Considering the good quality of our films and the large errors associated to magnetisation data extracted from standard techniques we performed a optical measurement as polar Kerr rotation measurements on the well characterised polycrystalline films used in this section up to high magnetic fields.

3.2.2 Magnetisation of polycrystalline and epitaxial films

In order to understand if the non saturating tendency of the MR at high magnetic fields corresponds to a change in the magnetisation of the films or to pure surface effects, we have performed measurements of Kerr rotation in the polar geometry up to fields of 32T. Such technique permits to avoid the contribution to the value of the magnetisation of the substrate or the errors associated to the film volume determination that are present when measuring with standard techniques as VSM or SQUID. The measurements were also performed at the SNCMP Toulouse using the same magnetic field production system as in the previous section and a pumped He cryostat.

The same samples were used for Kerr rotation measurements and for the resistivity measurements shown above so a direct relation can be established between the transport and the magnetic measurements.

In manganites Kerr rotation using 670nm wavelength source is rather low (0.016°) compared with another half-metal as the PtMnSb which exhibits 1.2° of Kerr rotation.

Polar Kerr rotation measurements on the epitaxial film at different temperatures are shown in Fig. 3-32. The sample seems to be fully saturated for temperatures below 170K.

Kerr rotation measurements performed on the LT polycrystalline sample at different temperatures are shown in Fig. 3-33. At low temperatures (5K) the saturation of the magnetisation is attained for low fields ($H=M_s=0.7T$) and the high field slope observed is very similar to the slope observed in the epitaxial film which is about –0.022 °/T. However the magnetisation at 80K is reduced when compared to the epitaxial film where measurements at low temperature display saturation up to temperatures about 170K (Fig. 3-32).

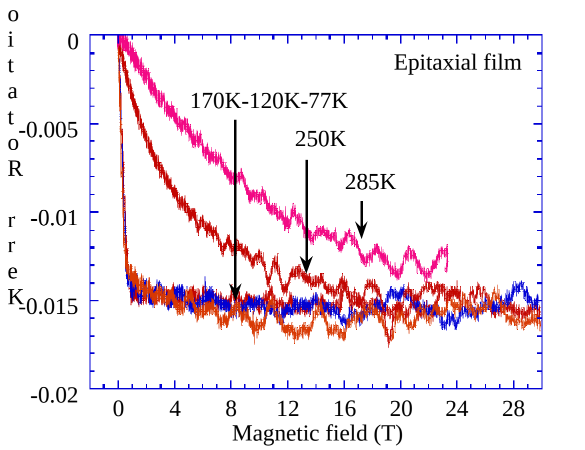

Fig. 3-32 *Polar Kerr rotation measurements performed to the epitaxial LCMO film on MgO at different temperatures*

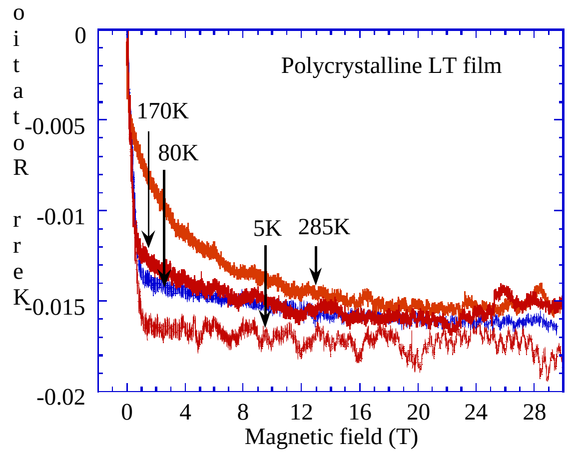

Fig. 3-33 *Polar Kerr rotation measurements performed to the LT polycrystalline LCMO film on MgO at different temperatures*

Therefore, Kerr measurements in the polar geometry suggest that the magnetisation of the polycrystalline film decrease faster than in the epitaxial film.

When comparing the value of the saturation magnetisation at low temperatures we observe that polycrystalline and epitaxial films display very similar values at very low temperatures (Fig. 3-34). The obtained values for the saturation magnetisation at 5K (0.65-0.69T) are smaller than the theoretical value for x=1/3 doping (0.74T). In this sense, some authors [97] have performed studies on the magnetisation of bulk polycrystalline $La_{0.7}Ca_{0.3}MnO_3$ samples and have evidenced a high field slope of 0.0004 μ_B/T and a extrapolated moment of 3.41 μ_B/Mn instead of the expected value (3.7μ_B/Mn) . This value of the saturation magnetisation is about 0.685T which in very good agreement with the values obtained in our films. Thomas et al. argued that in the high field magnetisation slope is one order of magnitude larger in $La_{0.7}Ca_{0.3}MnO_3$ than the one obtained for $La_{0.7}Sr_{0.3}MnO_3$ and they conclude the strontium based compound is fully aligned ferromagnet in agreement with other authors [98] while the ground state of LCMO is not a collinear ferromagnetic state.

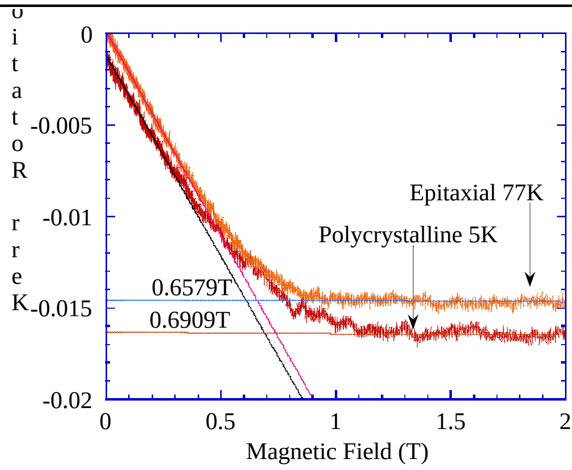

Fig. 3-34 *Saturation magnetisation for the epitaxial (77K) and polycrystalline film (5K)*

At 77K the polycrystalline films has lost a part of its magnetisation (Fig. 3-33) suggesting that even if at 5K the saturation is very close to the saturation for the epitaxial sample, as temperature is increased a part of the polycrystalline sample loses its magnetisation.

When comparing the Kerr measurements at 77K on the epitaxial and the polycrystalline samples (Fig. 3-36) it is possible to observe that above 15T the samples seem to exhibit the same behaviour and that for fields below 15T the polycrystalline sample exhibits a reduced magnetisation thus meaning that part of the sample is not fully FM. Transport measurements at similar temperatures (Fig. 3-35) show that there exist a huge difference of the CMR between both samples. These facts make us conclude that changes in the magnetic state of the sample can be at the origin of the large MR observed in polycrystalline films.

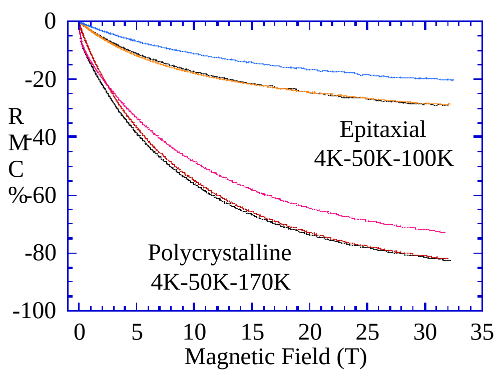

Fig. 3-35 *Transport measurements performed on the polycrystalline and epitaxial films at 50K and 170K.*

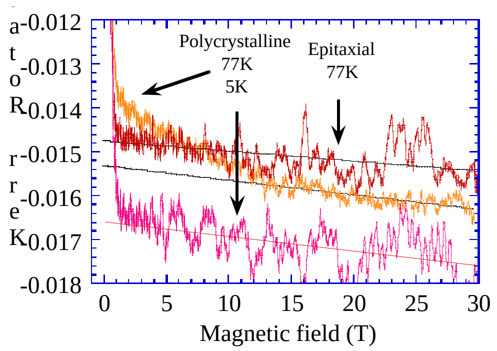

Fig. 3-36 *Comparison of the Kerr rotation measurement at 5K and 77K for the epitaxial and the polycrystalline films.*

The evolution of the magnetisation measured with the polar Kerr rotation seems to agree with the existence of PM component that adds to the FM component or of non-collinear FM structures .

In Fig. 3-37 are displayed the transport and magnetic measurements on the polycrystalline sample. At 50K and 170K we observe that the main difference in the transport measurements is for magnetic fields below 15T in agreement with magnetic measurements. Hence, the magnetic state of a part of the sample is tuning the transport behaviour.

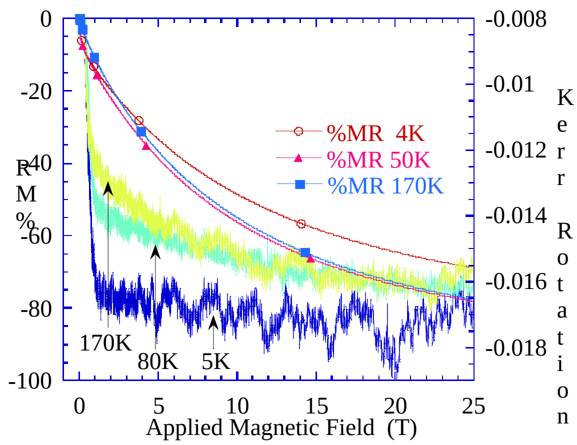

Fig. 3-37 *Transport and Kerr rotation measurements performed on the polycrystalline film at 4K, 50K and 170K*

From the above measurements, we conclude that a part of the polycrystalline sample is not fully FM ordered below T_C. The application of high magnetic fields tends to align