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Novel properties in the normal state and the mixed state due to multiband effect in MgB_2

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Based on high quality MgB_2 thin films, we measured the longitudinal and transverse resistivity of seven different samples with variable disorders characterized by the residual resistance ratio (RRR) ranging from 4.0 to 33.3. Strong nonlinear Hall effect and strong magnetoresistance have been found in clean samples and they decrease gradually with the increase of scattering centers or temperature. By fitting to the theoretical model for a four-band system, for the first time, we derived the scattering rates for each band. Nontrivial difference between the transport properties of these four bands are unraveled. In the mixed state, a non-vanishing dissipation has been observed in the low temperature regime. The Hall Effect measurement confirms that it is induced by the vortex motion. Together with the data of I-V curves, point-contact tunneling and the magnetization relaxation, we conclude that this non-vanishing dissipation in the zero temperature limit is induced by the proliferation of the pi-band quasiparticles, in association with the multigap feature. In collaboration with H. Yang, Y. Jia, J. R. Shi, L. Shan, C. Ren and Y. Z. Zhang at IOP, CAS and C. G. Zhuang, Z. K. Liu, Qi Li, Yi Cui, and X. X. Xi at Penn State University.