Synthesis of *c*-axis oriented Al-doped MgB_2 and charge carrier density characterized by Hall measurements

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We synthesize *c*-axis oriented Al-doped MgB_2 thin films on an Aluminum buffered layer of Al_2O_3 substrates by Hybrid Physical-Chemical Vapor Deposition (HPCVD) and have measured the longitudinal and the Hall resistivities in the *ab*-plane direction. X-ray Diffraction (XRD) shows a clear peak of 25.97º of (0001) $Mg_{1-x}Al_xB_2$ compared to 25.29º of (0001) MgB_2, indicating Al substituted on Mg position with x~0.25. The 185-nm $Mg_{1-x}Al_xB_2$ shows $T_{c,0}$ of 21.5 K with a broadened transition width of ~11 K. The broad transition is due to the high concentration dopants of Al, which also happened in bulk single crystals of Al-doped MgB_2. In the normal state, the Hall coefficient (R_H) is positive like pure MgB_2 and decreases as the temperature increases. The cotangent of the Hall angle was found to follow $\alpha + \beta T^2$ behavior from 120 K < T < 300 K. At T = 100 K, $R_H = 18.97 \times 10^{-11}$ m^3/C from which the hole charge carrier density was determined to be 3.29×10^{22} $/cm^3$.The suppression of hole charge carrier density compared to pure MgB_2 of ~1.5-2 $\times 10^{23}$ $/cm^3$ supports the hypothesis that Al^{3+} substitutes for Mg^{2+} by hole-neutralizing electron doping.