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Distant exchange interactions in $Cd_{1-x}Mn_xS$ from magnetization steps method

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ABSTRACT

Three new distant neighbor (DN) antiferromagnetic exchange constants have been measured in wurtzite $Cd_{1-x}Mn_xS$ ($x = 0.0087$ and $x = 0.0278$) using the magnetization steps method in the millikelvin regime. The second ($J^{(2)}$), third ($J^{(3)}$), and fourth ($J^{(4)}$) largest exchange constants (after the two first neighbor exchange interactions J_1 and J_1') have been measured. The results are $J^{(2)} = 300 \pm 10$ mK, $J^{(3)} = 173 \pm 10$ mK, and $J^{(4)} = 55 \pm 10$ mK. No significant change of the exchange constant values has been observed as a function of the Mn concentration. The mapping of the DN exchange interactions has been investigated within a sphere of radius 2 times the nearest neighbors distance. The only way to identify the J constants was using the number coordination Zn of the different DN classes: $J^{(2)}$ is associated to DN classes with $Z_n = 6$, $J^{(3)}$ with $Z_n = 12$, and $J^{(4)}$ is ascribed to a group of three DN classes with J values around $J^{(4)}$. The magnitude of the J constants is not in agreement with theoretical predictions of the monotonic decrease of the exchange constant with increasing distance. The present results are similar to those obtained for $Cd_{1-x}Mn_xSe$ but are different from the ones obtained for $Zn_{1-x}O$. The present work confirms the long-range character of the DN exchange interactions in the wurtzite

type MnTe based II–VI diluted magnetic semiconductors.

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