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Microhardness of $Cd_{1-x}Mn_xTe$ solid solutions

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The distribution coefficient of Mn (k_s) in $Cd_{1-x}Mn_xTe$ ($0.02 \le x \le 0.55$) solid solutions crystals grown by Bridgman technique has been determined using the radioisotope method. Microhardness of $Cd_{1-x}Mn_xTe$ solid solutions has been studied by Vickers technique. It is found that the Mn distribution homogeneity along the ingot depends on the synthesis duration. The Mn distribution coefficient for homogenized $Cd_{1-x}Mn_xTe$ solid solutions is $k_s = 1$. With the increase of manganese content in $Cd_{1-x}Mn_xTe$ solid solution up to $x = 0.15$, the microhardness increases linearly, reaches a maximum, and then some decrease of the microhardness occurs.

В выращенных методом Бриджмена кристаллах твердых растворов $Cd_{1-x}Mn_xTe$ ($0,02 \le x \le 0,55$) проведены определения коэффициента распределения (k_s) марганца радиоизотопным методом и измерение микротвердости по методу Виккерса. Однородность распределения Mn по слитку зависит от времени синтеза. Коэффициент распределения марганца для гомогенизированных твердых растворов $Cd_{1-x}Mn_xTe$ равен $k_s = 1$. Микротвердость при увеличении содержания марганца в твердых растворах $Cd_{1-x}Mn_xTe$ до $x = 0,15$ линейно возрастает и достигает максимума, а затем происходит незначительное ее снижение.

The interest in $Cd_{1-x}Mn_xTe$ crystals is increased in recent years due to promising applications of the material in electronics. To date, the reliable data are available on the physicochemical interaction in CdTe–MnTe–Te system. The binary CdTe and MnTe solid solutions are formed: from CdTe side, up to 77 mole % of MnTe [1, 2] and 71.4 mole % of MnTe at 1070 K [3]; and from MnTe side (α-modification, 1070 K) up to 0.3 mole % of CdTe [3]. The presence of $MnTe_2$ and MnTe compounds with four high-temperature polymorph transformations in Mn–Te system complicates the growing of uniphase, homogeneous, structurally perfect material. Therefore, data on $Cd_{1-x}Mn_xTe$ solid solutions microhardness obtained by different authors [2, 4, 5] are not fully consistent. The purpose of this work is to study the Vickers microhardness (H_V) of $Cd_{1-x}Mn_xTe$ ($0 \le x \le 0.55$) solid solutions as a function of the solid solution composition as well as to investigate its phase composition by radioisotope method. The accuracy of radioisotope quantitative determination was of ±5 %. The distribution coefficient k_s was calculated using Pfann formula [6]. The microstructure and microhardness of $Cd_{1-x}Mn_xTe$ ($0 \le x \le 0.55$) crystals were studied using a PMT-3 setup by the technique presented in [7]. The microhardness was determined on 2 or 3 samples prepared from different crystals of the same stoichiometry. More than 10 indentions have been made on each sample and the average value of H_V was determined (the measurement error did not exceed 3 %). It was found that microhardness of $Cd_{1-x}Mn_xTe$ solid solutions at low indentor loading values (5 to 20 g) increases monotonously with the loading increasing. Micro-

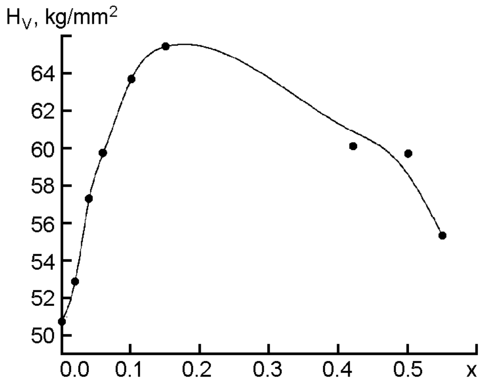

Fig. Measured microhardness of $Cd_{1-x}Mn_xTe$ solid solutions.

hardness of CdTe and $Cd_{1-x}Mn_xTe$ solid solutions virtually is independent of the loading within limits of 20 to 100 g. Therefore, the optimum loading was chosen to be of 50 g.

The crystal raw materials were synthesized at 1390 K. The crystals were grown by Bridgman method, temperature gradient at crystallization front was 10 to 15 K/cm, the growth speed was of 2 mm/h. The structurally perfect crystals with homogeneous distribution of components along the ingot were grown at long (more than 70 hours) synthesis duration. The manganese distribution coefficient k_s for crystals with manganese content of 0.1 to 0.45 is about 1. The variation of H_V value along the ingot did not exceed the experimental error.

The measured dependence of $Cd_{1-x}Mn_xTe$ solid solutions microhardness H_V on manganese content are presented in Fig. As the manganese content increases up to $x = 0.15$, the microhardness increases linearly, reaches a maximum, and then some decrease of the microhardness occurs. The solid solution formation is accompanied as a rule by an increase of hardness. In the case when continuous lines of solid solutions are formed, the concentration dependence of H_V is described by a smooth curve with a maximum.

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Мікротвердість твердих розчинів $Cd_{1-x}Mn_xTe$

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У вирощених методом Бріджмена кристалах твердих розчинів $Cd_{1-x}Mn_xTe$ ($0,02 \le x \le 0,55$) проведено визначення коефіцієнта розподілу (k_s) марганцю радіоізотопним методом і вимірювання мікротвердості за методом Віккерса. Однорідність розподілу Mn вздовж злитку залежить від часу синтезу. Коефіцієнт розподілу марганцю для гомогенізованих твердих розчинів $Cd_{1-x}Mn_xTe$ рівний $k_s = 1$. Мікротвердість при збільшенні вмісту марганцю у твердих розчинах $Cd_{1-x}Mn_xTe$ до $x = 0,15$ лінійно зростає і досягає максимуму, а потім відбувається незначне її зниження.