Functional Materials 10, No.4 (2003)

Crystal nucleation and growth during the annealing of laser-deposited amorphous condensates of chromium oxide

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Received December 12, 2002

Structural and morphologic features of crystallization of amorphous films obtained by laser sputtering of chromium targets in oxygen atmosphere have been investigated. The amorphous-to-crystal phase transition was studied both under radiation heating of the film by electron beam in the electron microscope column ("in situ" technique) and under thermal annealing in air in a furnace. In both cases, the amorphous films having a composition close to Cr_2O_3 are crystallized in a polymorphous fashion (without changing the composition). The crystal growth activation energy was about 106 kJ/mol. A complex bending of crystal lattice having the elastic rotational distortion has been shown to occur at the crystallization. The bending of crystal lattice has been revealed using the bend contours.

Исследованы структурные и морфологические особенности кристаллизации аморфных пленок, полученных лазерным распылением хромовых мишеней. Фазовый переход из аморфного в кристаллическое состояние изучали как при радиационном нагреве пленки электронным лучом в колонне микроскопа (методика "in situ"), так и при термическом отжиге на воздухе в печи. В обоих случаях аморфные пленки, состав которых был близок к Cr_2O_3, кристаллизовались полиморфно (без изменения состава). Энергия активации роста кристаллов составляла ~106 кДж/моль. Показано, что при кристаллизации имеет место сложный изгиб кристаллической решетки, носящий характер упругой ротационной дисторсии. Изгиб кристаллической решетки выявляли методом изгибных контуров.

The structure and phase state of films deposited using the pulse laser sputtering of a metal target depends on many factors, the following being the critical ones: the vapor-plasma flow density in the substrate plane, J_1; the density of gas atmosphere particles in the evaporation chamber, J_2; the metal capability of gas impurity adsorption and formation of chemical compounds therewith; the substrate type, orientation, and temperature T_s. In [1], a diagram is presented (see Fig. 1) summarizing the structure study results for films deposited using the pulse laser sputtering of different metal targets at $T_s = 293$ K. The abscissa values of the diagram present the initial oxygen adsorption heat Q_0 on metal films deposited at 298 K. The ordinate is the dimensionless parameter

$$\Gamma_U = \int_0^{\tau} J_2(t)dt \Big/ \int_0^{\tau_1} J_1(t)dt$$

where τ and τ_1 are the period and duration of the substance condensation pulses, re-