Functional Materials 10, No.2 (2003)

Texturing of CVD diamond films

S.N.Samsonenko, N.D.Samsonenko, Z.I.Kolupaeva*

Donbass State Academy for Building and Architecture, 2 Derzhavin St., 86123 Makeevka, Donetsk obl., Ukraine
*National Technical University "Kharkiv Polytechnical Institute", 21 Frunze St., 61002 Kharkiv, Ukraine

Received June 27, 2002

Texturing of polycrystal diamond films (PDF) has been studied by X-ray diffraction using sliding beams and θ–2θ protocol. The PDF samples were grown from gas phase on single crystal silicon substrates. The substrate temperature and the methane-hydrogen mixture pressure were varied in the experiments. In about 3 μm PDF, a feeble texturing occurs manifested as an intensification of the (111) diffraction line. As the gas mixture pressure increases, the pole density of the (111) texture becomes reduced while that of the (220) one rises, so at p = 240 Torr, the pole densities of both structures approach 1, thus answering to the ideal PDF polycrystallinity. In 4 to 6 μm thick PDF and 9 to 11 μm thick ones, the (311) texture or (220) one predominates, depending on the synthesis conditions. At p = 160 Torr and the substrate temperature 1173 K, it is just the (220) texture that predominates, the maximum PDF growth rate being corresponding to that texture. The dislocation density measurements in PDF demonstrated a correlation with the pole density of the (311) texture.

Исследовано текстурирование поликристаллических алмазных пленок (ПАП) методом рентгеновской дифракции с использованием скользящих пучков и схемы θ–2θ. Образцы ПАП выращивались из газовой фазы на подложках из монокристаллического кремния. В опытах варьировалась температура подложек и давление метан-водородной смеси. В ПАП толщиной около 3 мкм имеет место слабое текстурирование, выражающееся в усилении дифракционной линии (111). При повышении давления газовой смеси полюсная плотность текстуры (111) уменьшается, а текстуры (220) — возрастает и при p = 240 Торр полюсные плотности этих текстур приближаются к 1, что соответствует идеальной поликристалличности ПАП. В ПАП толщиной 4÷6 мкм и 9÷11 мкм в зависимости от условий синтеза преобладает текстура (311) или (220). При давлении 160 Торр и температуре подложек 1173 К преобладает текстура (220) и ей соответствует максимум скорости роста ПАП. Измерение плотности дислокаций в ПАП показали корреляционную связь с полюсными плотностями текстуры (311).

It is known [1, 2] that epitaxial diamond films (EDF) and polycrystal ones (PDF), as their thickness increases in the course of synthesis, pass from the single crystal EDF or uniaxial PDF layers via polycrystal structure to the (220) texture with the layer growth direction along [110] axis at significant thickness (exceeding about 20 or 30 μm). Since the structure and defect system of diamond films define their electronic properties, it is of interest to study the texture formation conditions during the synthesis, the transition from one texture to another, and interrelation between the texture and structure defects.

The diamond films were grown using the high-gradient chemical transport reaction (HGCTR) under thermal activation of gas phase [1]; graphite heated up to 2273 to 2373 K was used as activator. The single crystal silicon plates having the (111) growth planes were used as substrates. The