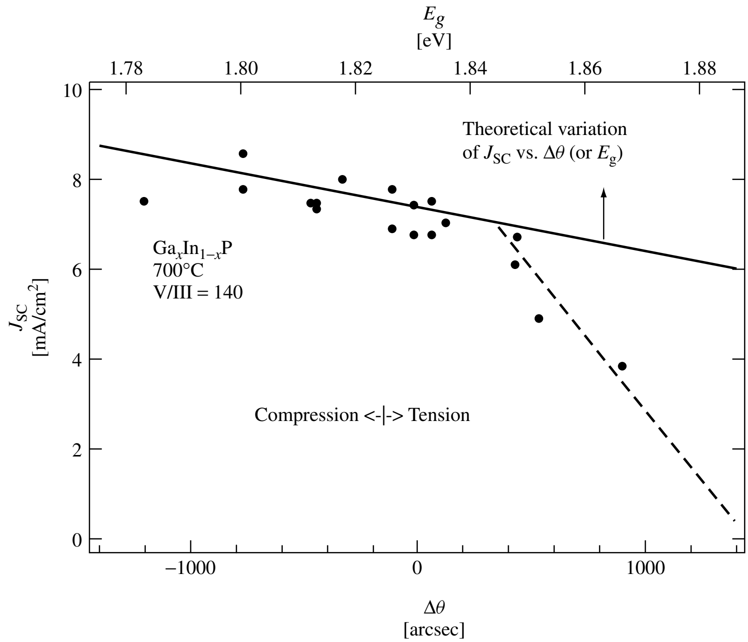

Figure 9.12 Saturated photoelectrochemical current density of $Ga_xIn_{1-x}P$ as a function of the lattice mismatch as measured by X-ray rocking-curve peak separation in units of arc seconds, or equivalently as a function of the resulting E_g [35]. The growth temperature is 700°C and V/III ratio (PH_3/(TMGa + TMIn)) is 140. The dashed line is included to guide the eye

where θ_B is the Bragg angle and $\nu_{GaP}x + \nu_{InP}(1 - x)$ is the Poisson ratio for $Ga_xIn_{1-x}P$ obtained from Poisson ratios for GaP and InP (see Table 9.3). (The Poisson ratio is defined as the negative of the ratio of the lateral to the longitudinal strains under uniaxial stress.) If the epilayer is fully relaxed, the last multiplicative term of equation (9.19) goes to one. A plot of $\Delta\theta$ versus x for $Ga_xIn_{1-x}P$ on GaAs for these two extremes is shown in Figure 9.13(a). The critical layer thickness is simply the balance between the coherent energy created by strain, the relief of this strain energy by the introduction of dislocations, and the self-energy of dislocations. Below the critical layer thickness, the lowest-energy state of the system is an epilayer with a lattice constant, in the plane of the interface between the epilayer and the substrate, equal to the lattice constant of the substrate. Above the critical epilayer thickness, the lowest-energy state is one composed of some epilayer strain and some strain-relieving dislocations. The problem was first solved by Matthews and Blakeslee [36]. The relationship between lattice mismatch and layer thickness is shown in Figure 9.13(b).

Referring to Figure 9.12, for $\Delta\theta = 0$, the critical layer thickness is infinite and J_{SC} is a measure of the intrinsic minority-carrier transport quality of the epilayer in the absence of misfit dislocations. The solid line with negative slope is the theoretical variation of J_{SC} with $\Delta\theta$. For $\Delta\theta < 0$, the epilayer is In-rich ($x < x_{LM}$), and its band gap is lower than that of lattice-matched $Ga_xIn_{1-x}P$. Hence, J_{SC} increases with decreasing $\Delta\theta$. For $\Delta\theta > 0$, the epilayer is Ga-rich ($x > x_{LM}$). At first, J_{SC} decreases with increasing $\Delta\theta$ in line with the In-rich portion of the curve, but then falls off rapidly with increasing $\Delta\theta$. The critical