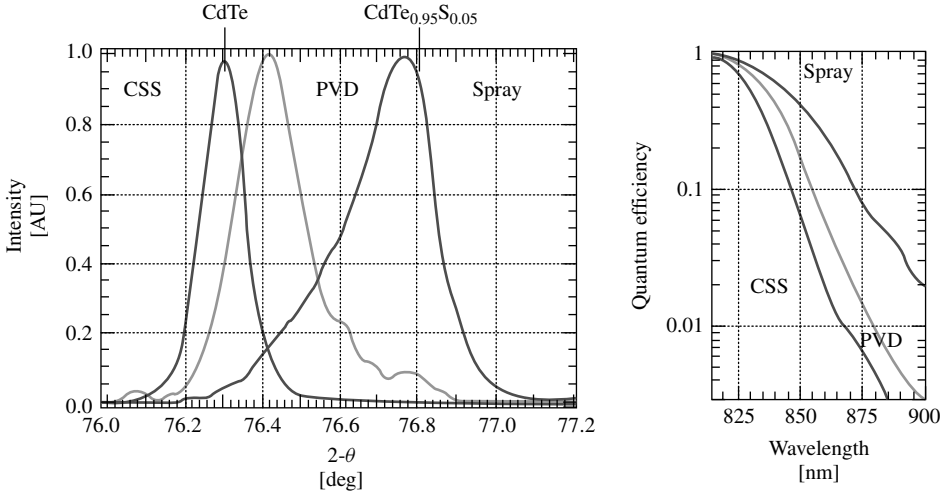

Figure 14.19 Correlation of XRD (511)/(333) reflection with long-wavelength quantum efficiency

copper-containing material. Copper will react with Te to form a p^+-layer that can then be contacted with a metal or with graphite. The subtelluride Cu_2Te has been directly measured at the back surface using GIXRD methods [151]. Also, Cu acts as a relatively shallow donor in CdTe and can be diffused into CdTe from a doped contact material such as graphite paste [34] or ZnTe:Cu [205].

There are a variety of surface treatments that have been used, prior to formation of the copper layer, to reduce the back barrier. Table 14.3 gives a summary of these surface treatments and the corresponding materials that have typically been used for the back contact. Although fabrication laboratories tend to utilize a single surface treatment and contact material, there is little evidence that the preferred contact process is dependent on the deposition technique.

The high bulk-diffusion coefficient for Cu in CdTe, 3×10^{-12} cm^2/s at 300 K [156], coupled with its multiple valence states and weak Cu–Te bond give rise to potential stability issues related to its use as discussed below. Alternatives to the use of copper in the back

Table 14.3 Back-contact formation methods (NP = nitric + phosphoric acid mixture, BDH = sequential reaction in bromine, acidic dichromate, and hydrazine)

CdTe deposition method	Surface treatment	Primary contact	Thermal treatment	Additional contact	Reference
PVD	Te + H_2	Cu	200°C/Ar	C	[152]
ED	BDH	Cu	None	Ni or Au	[153]
Spray	Etch	C + dopant	None	None	[154]
Screen	None	C + Cu dopant	400°C/N_2	None	[155]
VTD	BDH	Cu	200°C/Ar	C	[151]
CSS	NP Etch	C + HgTe + Cu	200°C/He	Ag paste	[84]
Sputter	Br Etch	ZnTe:N	In situ	Metal	[156]
MOCVD	Br Etch	ZnTe:Cu	In situ	Metal	[157]