

2.5. ELECTRON DIFFRACTION AND ELECTRON MICROSCOPY IN STRUCTURE DETERMINATION

Table 2.5.3.14. Diffraction groups and CBED symmetries for two icosahedral point groups

Point group	Diffraction group	BP	WP	DP	\pm DP
235	$5m_R$	$5m$	5	1	1
				m_R	
				m_2	1
	(Projection) $5m1_R$	10mm	5m	2 = 1_R	1
				$2m_v m_2$	1
$m\bar{3}5$	$10_R mm_R$	10mm	5m	1	2_R
				m_2	$2_R m_2$
				m_v	$2_R m_v$
	(Projection) $10mm1_R$	10mm	10mm	2	21_R
				$2m_v m_2$	$21_R m_v$

dimensions (e.g. Jarić, 1988). A quasicrystal is produced by the intersection of the six-dimensional crystal with an embedded three-dimensional hyperplane (the cut-and-projection technique).

Addition of several per cent of silicon to Al–Mn alloys caused a great increase in the degree of order of the quasicrystal. Bendersky & Kaufman (1986) prepared such a less-strained quasicrystalline $Al_{71}Mn_{23}Si_6$ alloy and determined its point group. They obtained fairly good zone-axis CBED patterns that showed symmetries of 10mm, 6mm and 2mm in the ZOLZ discs and 5m, 3m and 2mm in HOLZ rings. From these results, they identified the point group to be centrosymmetric $m\bar{3}5$. Figs. 2.5.3.24(a)–(f) show three pairs of CBED patterns taken from an area about 100 nm thick and about 3 nm in diameter of an $Al_{74}Mn_{20}Si_6$ quasicrystal at an accelerating voltage of 60 kV (Tanaka, Terauchi & Sekii, 1987). This quasicrystal was found to have much better ordering than $Al_{71}Mn_{23}Si_6$. The fact that Kikuchi bands are clearly seen in the HOLZ patterns and the profiles of the bands are symmetric with respect to their

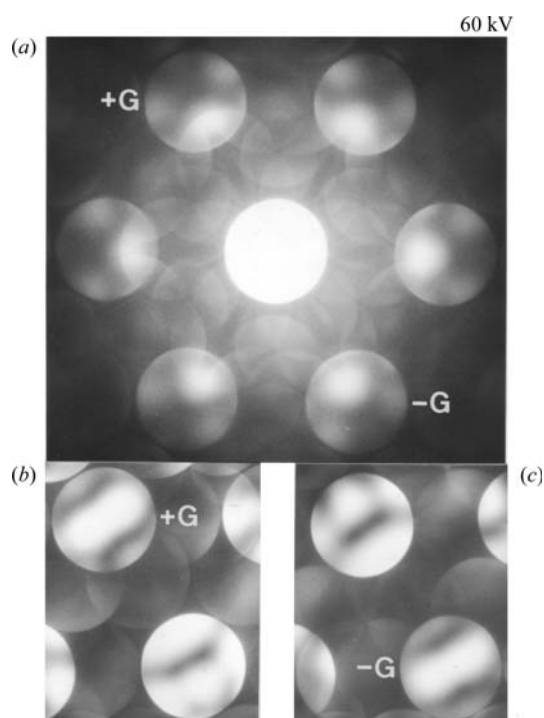


Fig. 2.5.3.25. CBED patterns of $Al_{74}Mn_{20}Si_6$ taken with an electron incidence along the threefold axis. (a) Zone-axis pattern showing symmetry 3m. (b, c) \pm DP showing translational symmetry or 2_R , indicating that the quasicrystal is centrosymmetric.

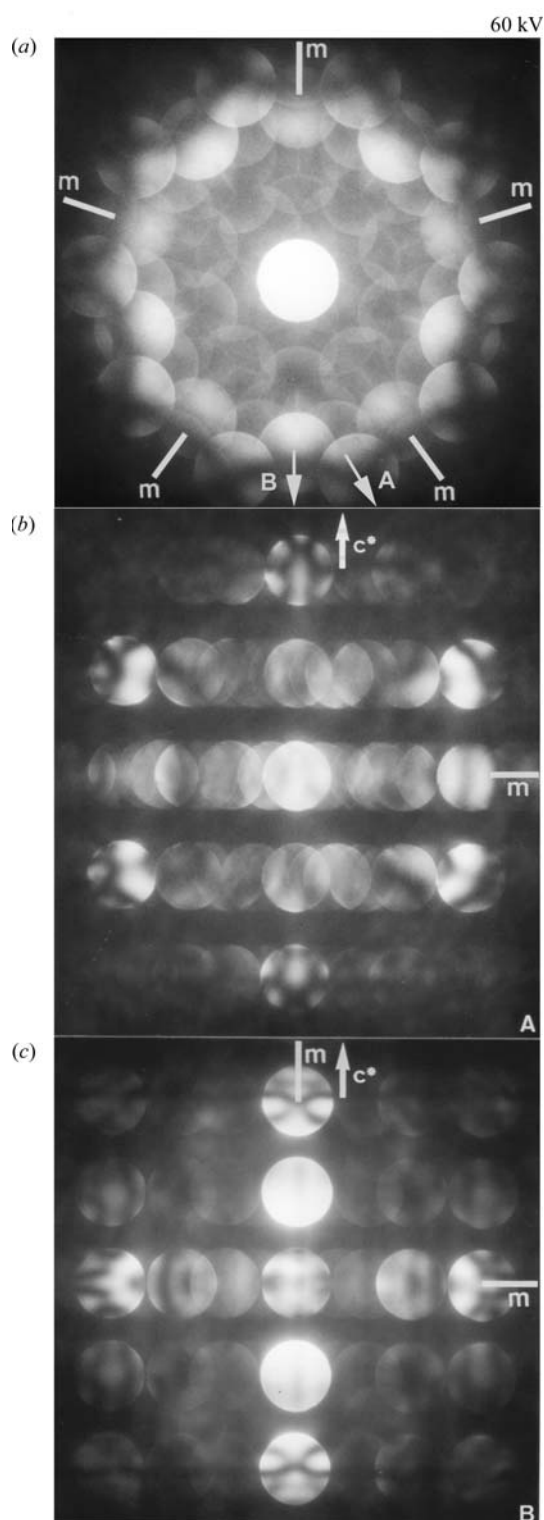


Fig. 2.5.3.26. CBED patterns of metastable $Al_{70}Ni_{15}Fe_{15}$ taken from a 3 nm diameter area. (a) Electron incidence along the decagonal axis; symmetry 5m. (b) Electron incidence along direction A indicated in (a); symmetry m perpendicular to the decagonal axis. (c) Electron incidence along direction B indicated in (a); symmetry 2mm. This alloy is found to be noncentrosymmetric.

centre indicates (Figs. 2.5.3.24b, d and f) that the quasicrystal has sufficiently good quality or highly ordered atomic arrangements to perform reliable symmetry determination. Each pair of CBED patterns consists of a ZOLZ pattern and a HOLZ pattern. The former is produced solely by the interaction of ZOLZ reflections, showing distinct symmetries in several discs.

The whole pattern of Fig. 2.5.3.24(a), formed by ZOLZ reflections, exhibits a tenfold rotation symmetry and two types of mirror symmetry, the resultant symmetry being expressed as