CARNEGIE MELLON UNIVERSITY
DEPARTMENT OF
MATERIALS SCIENCE AND ENGINEERING

Thermomechanical Processing Textures, part 3

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27-750

Texture, Microstructure & Anisotropy

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Objective

- Part 3 of the notes on typical textures covers solidification textures and textures in *hexagonal* metals and composites.

Solidification texture: <100> growth directions

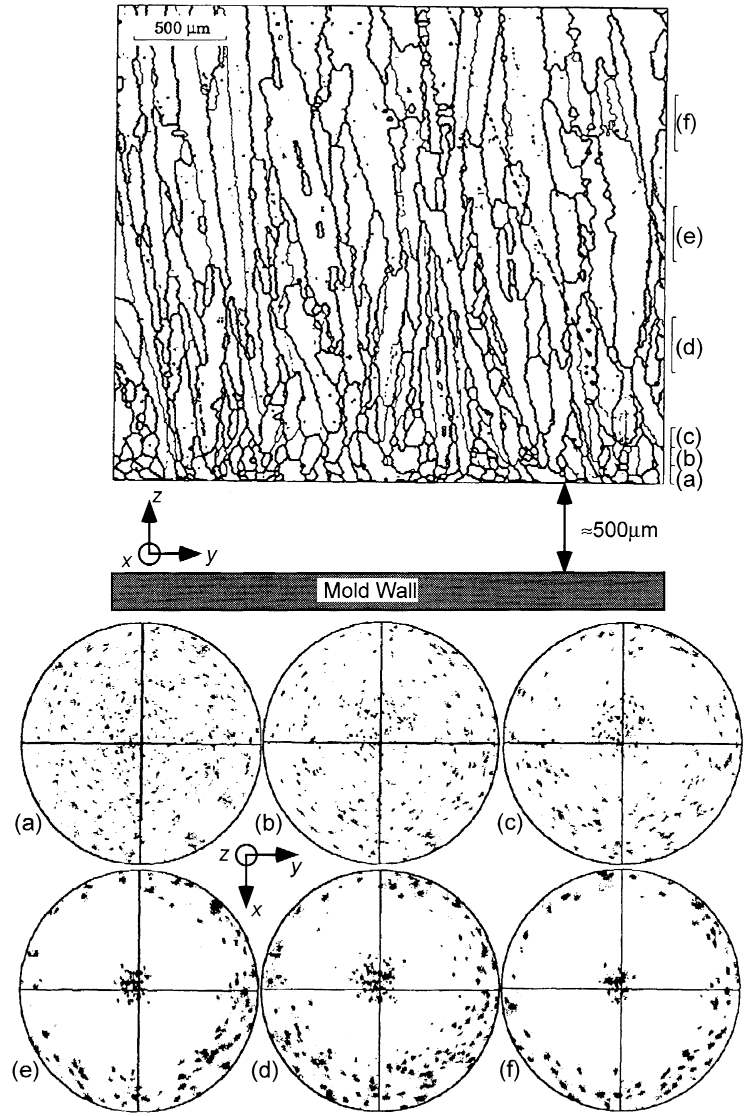


Fig. 47. Grain boundary map and corresponding discrete 100 pole figures for an Inconel X750 alloy cast on a copper chill plate in a ceramic mold. Pole figures are given for measurements in bands in the measurement domain at (a) 0 to 0.1 mm; (b) 0.1 to 0.2mm; (c) 0.2 to 0.3 mm; (d) 0.6 to 0.9 mm; (e) 1.2 to 1.5mm and (f) 1.8 to 2.1mm [GANDIN &AL. 1995].

Melt-spun Palladium

columnar structures

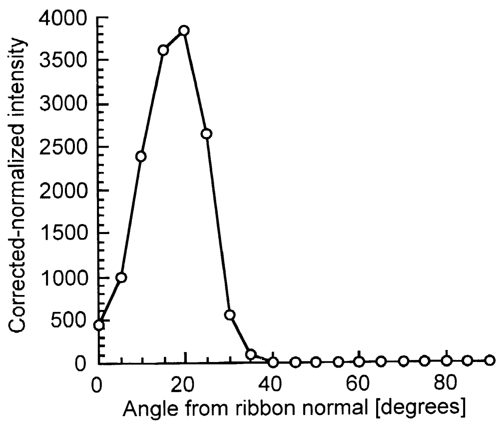


Fig. 50. Plot of intensity in 200 pole figure showing that the tilt from the ribbon normal is about 20°.

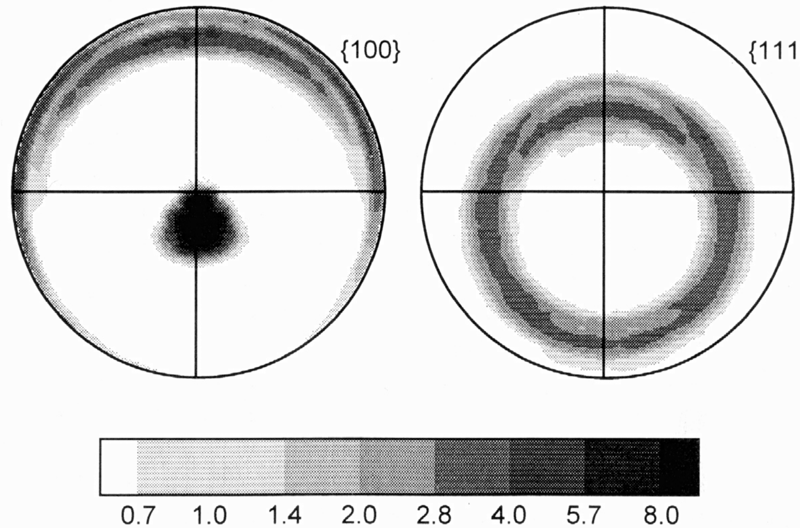


Fig. 48. 100 and 111 pole figures for melt-spun palladium, showing a strong ⟨100⟩ fiber corresponding to a growth direction from the melt that is tilted with respect to the plane of the ribbon. Equal-area projection.

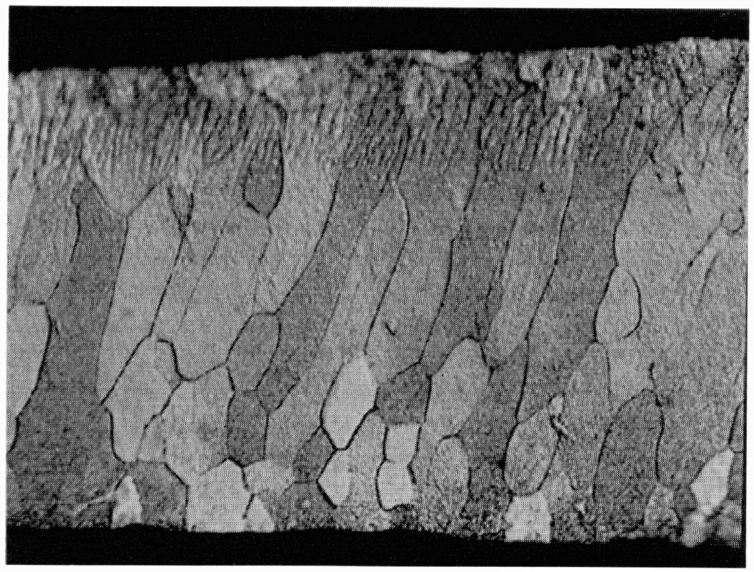


Fig. 49. Micrograph of melt-spun palladium ribbon, see previous figure for texture, showing columnar structure with tilted growth direction corresponding to texture result.

Hexagonal Metals

- Common to show the (0001) pole figure: provides most information needed.
- Easy slip on the basal plane means that compression generally aligns the basal plane normal with the compression axis.
- Tension typically aligns basal plane normals perpendicular to the axis.

Uniaxial textures in Ti

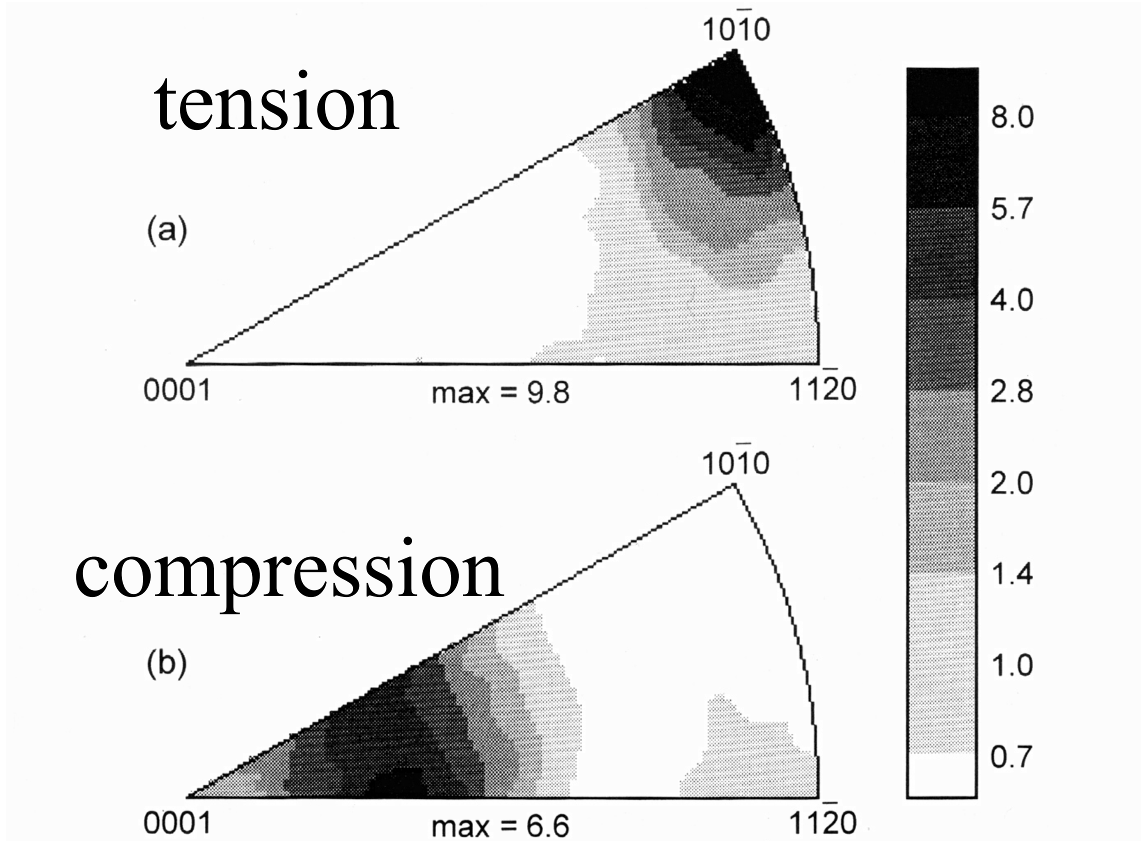


Fig. 20. Inverse pole figures of pure titanium: (a) extruded to a von Mises equivalent strain of 1.75 (extrusion-axis inverse pole figure), (b) forged and cross-rolled to a von Mises equivalent strain of 1.98 (plate normal inverse pole figure).

Compression:
25° from 0001,
~ <11-24>

Zr: compression

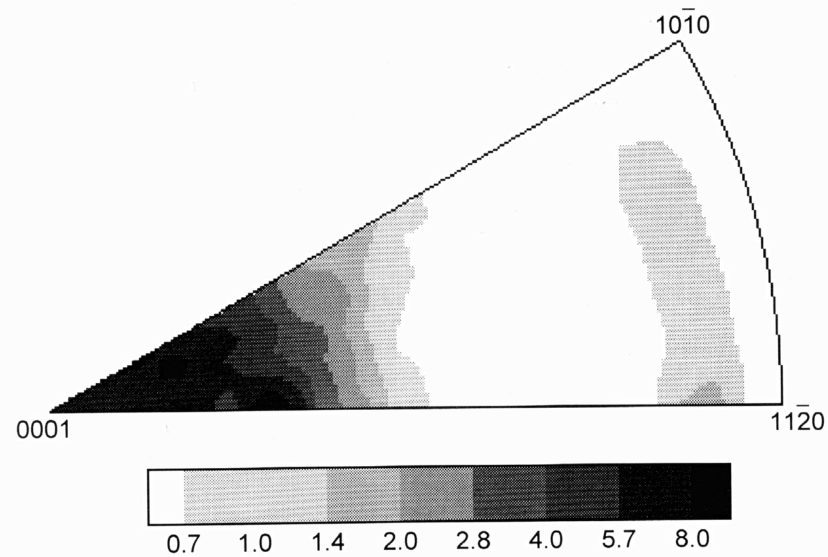
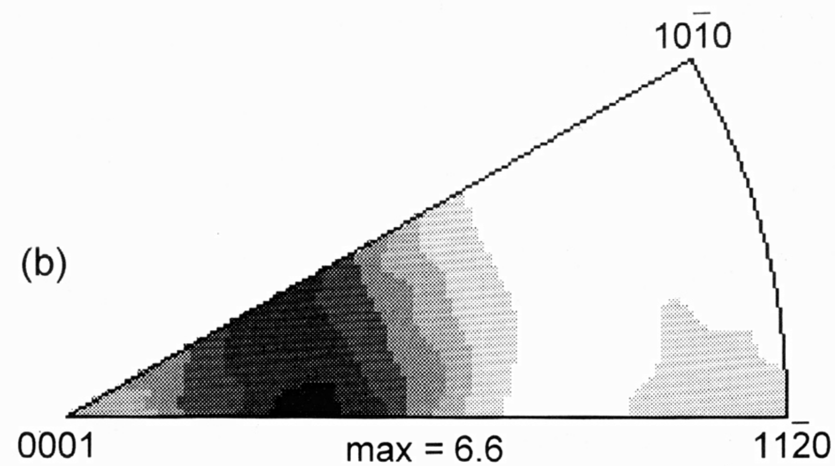


Fig. 21. Inverse pole figure (plate normals) for forged and cross-rolled zirconium, showing fiber texture near 0001.

Ti: compression



hcp Rolling Textures; schematic

c/a > 1.633:
RD split in 0001

c/a < 1.633:
TD split in 0001

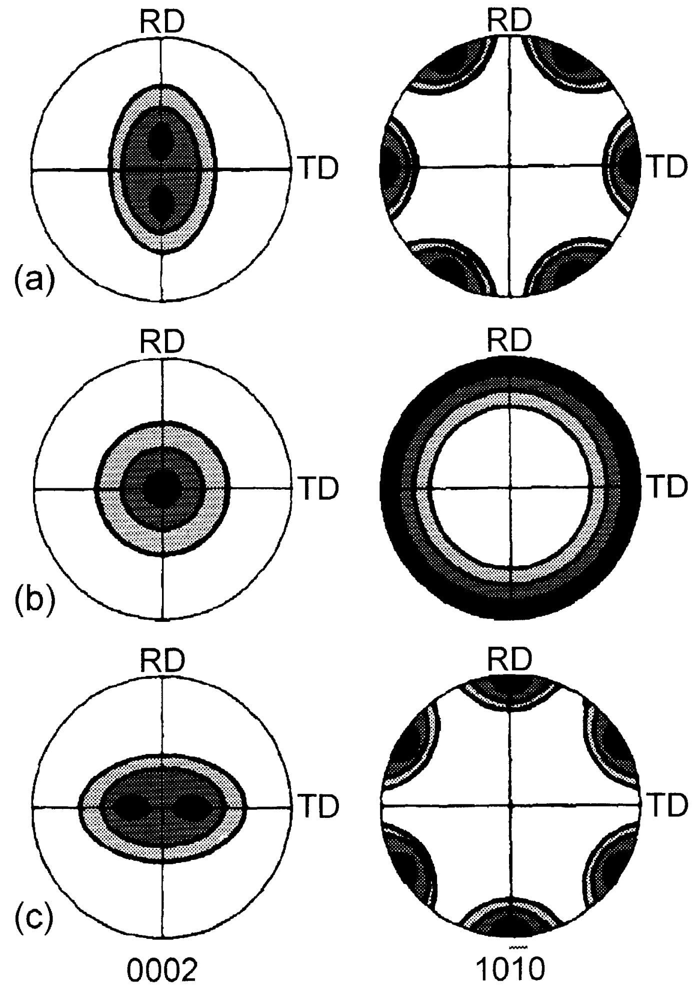


Fig. 22. Schematic rolling textures in hcp metals with *c/a* ratios of (a) greater than 1.633, (b) approximately equal to 1.633 and (c) less than 1.633. 0002 and $10\bar{1}0$ pole figures. [TENCKHOFF 1988].

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hcp Rolling Textures: exptl.

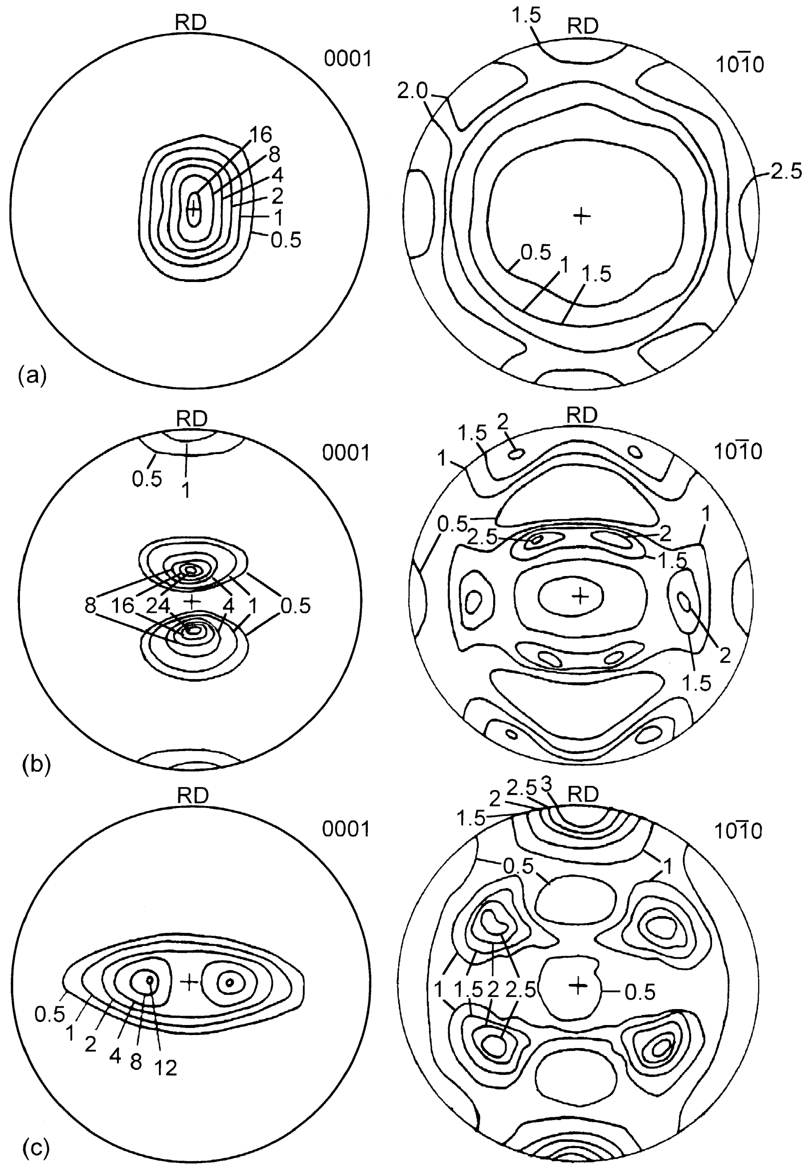

Fig. 23. 0002 pole figures for rolled (a) magnesium, (b) zinc, and (c) titanium, showing ⟨0001⟩ fiber for Mg, RD split for Zn, and TD split for Ti [GREWEN 1973] (stereographic projection).

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hcp: Rolling: strain dependence

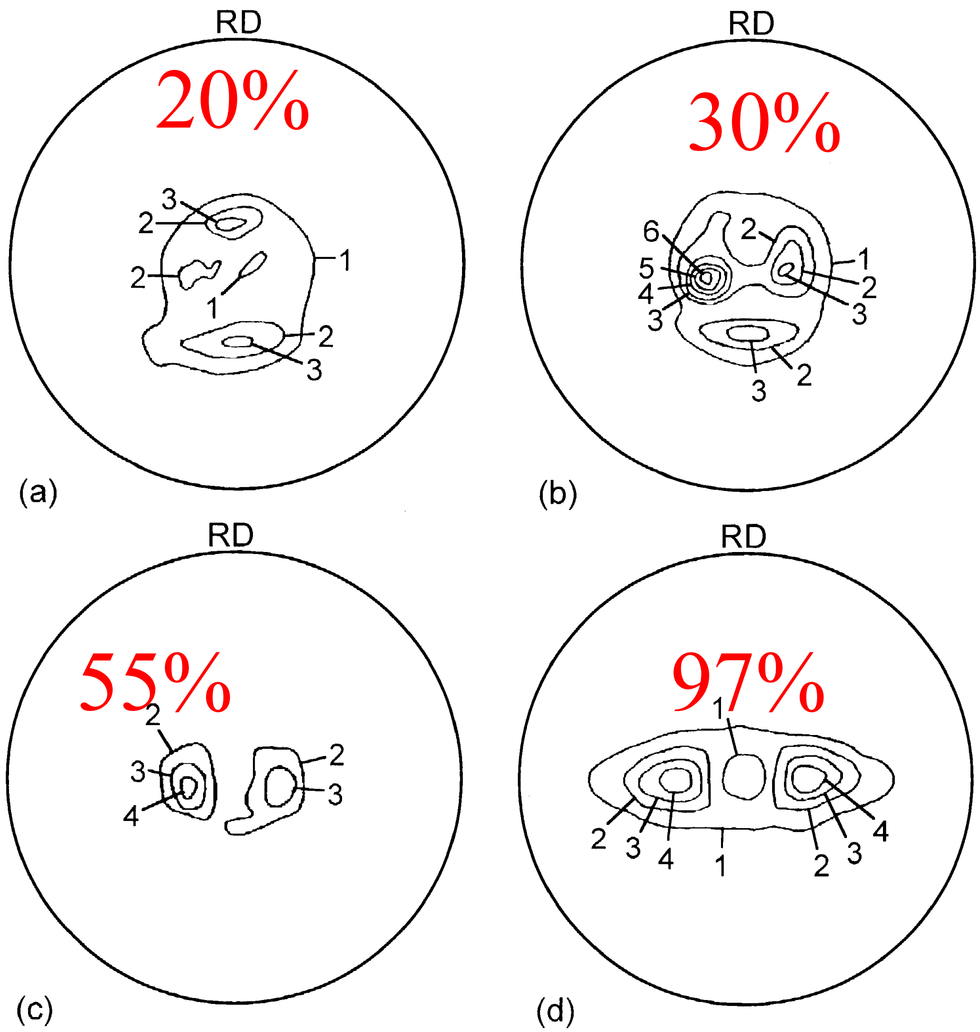

Fig. 24. 0002 pole figures for α-Ti sheet cold–rolled to thickness reductions of (a) 20%, (b) 30%, (c) 55% and (d) 97%. [BLICHARSKI &AL. 1979]. Stereographic projection.

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Al-SiC composites

- Reinforcement tends to randomize texture

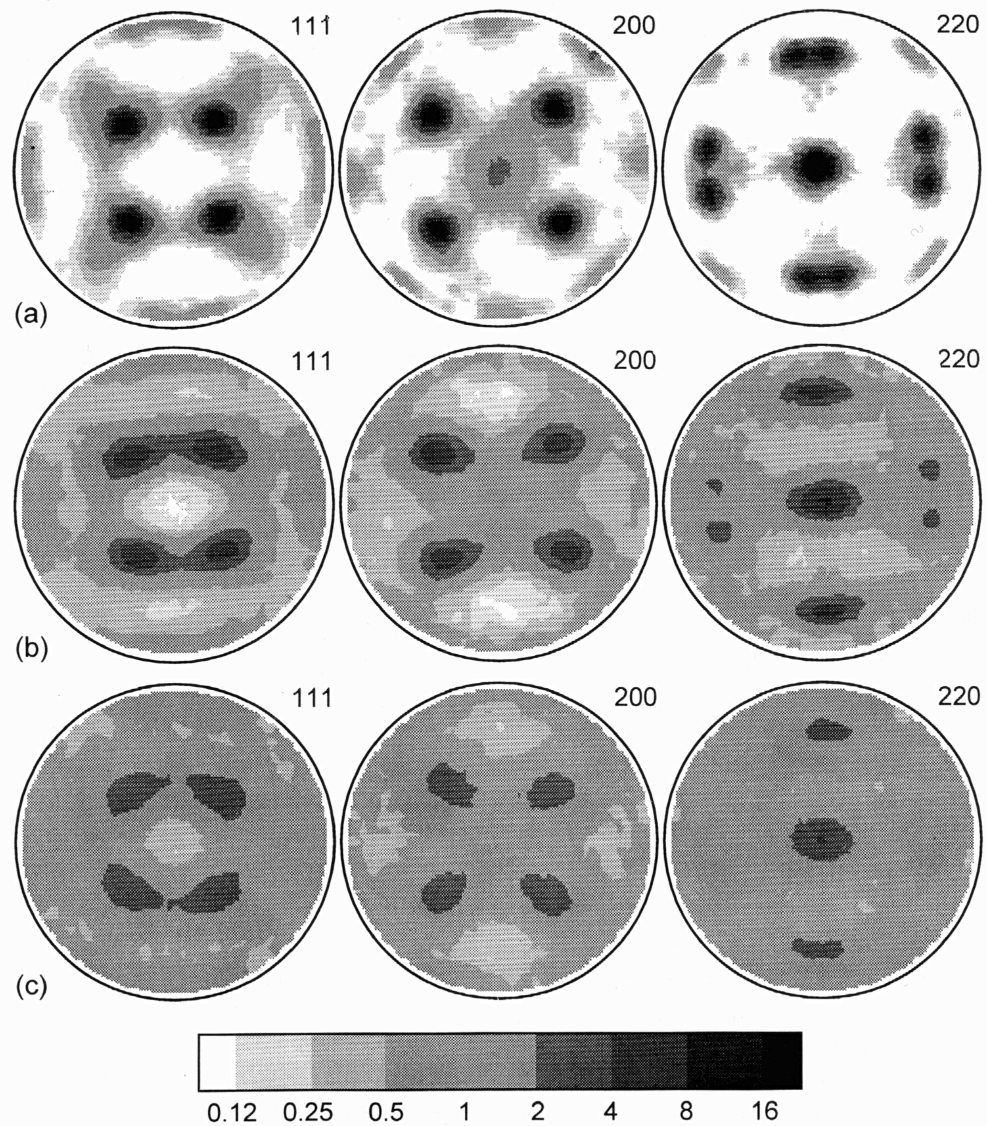

Fig. 34. 111, 200 and 220 pole figures for three extruded 8090 Al alloys with the following levels of SiC whisker reinforcement: (a) 0%, (b) 15%, and (c) 30%. Extrusion axis vertical, equal-area projection.

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Al-SiC:

Fibers vs. particles:

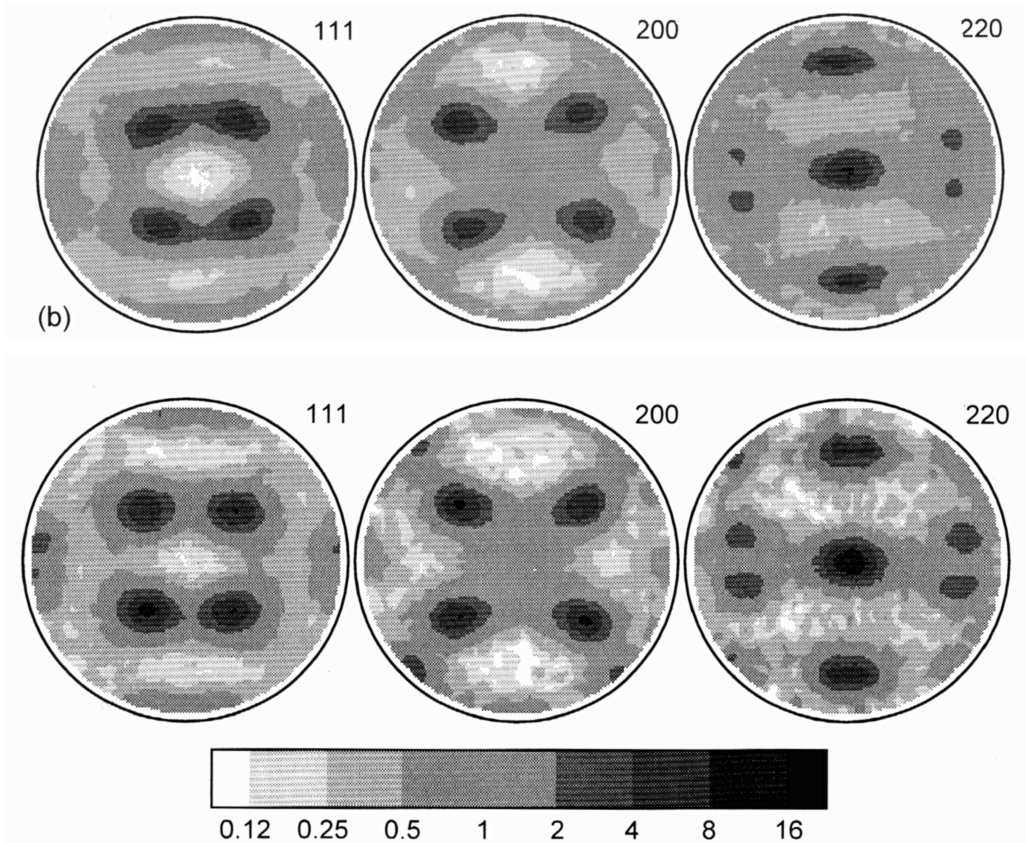

Fig. 35. 111, 200 and 220 pole figure for extruded 8090 aluminum with 15% SiC particles. Compare with Fig. 34b. Extrusion axis vertical, equal-area projection.

- Randomization from particles less than for fibers

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Summary: part 3

- Typical textures illustrated for solidification, metal matrix composites and for deformed hexagonal metals.
- Solidification textures can be strong but are often ignored in processing histories!
- Significant alloy dependence observed in hexagonal metals.
- Composites generally have weaker textures than equivalently deformed single phase metals.