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COMPARISON OF INCOMPLETE POLE-FIGURE METHODS FOR SURFACES PERPENDICULAR TO ROLLING, TRANSVERSE AND NORMAL DIRECTIONS

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Coefficients for a generalized-spherical-harmonic expansion of the crystallite orientation distribution function (ODF) through $L = 16$ were obtained by an incomplete pole-figure method from a deep-drawing aluminum-killed sheet steel sample with surface perpendicular to the sheet-normal direction (ND). These coefficients were subsequently transformed from the RD, TD, ND reference frame to −ND, TD, RD and ND, RD, TD reference frames. Spherical-surface-harmonic expansions of incomplete {110}, {100}, and {112} pole-figures were calculated for each reference frame and used as input data to calculate ODF coefficients for each frame. The thus-calculated coefficients were transformed to the RD, TD, ND frame in each case. Series expansions of pole-figures and ODF for each frame are compared with the initial data.

KEY WORDS ODF analysis, calculated pole-figures, reference frames.

INTRODUCTION

The use of incomplete pole-figure methods with composite samples having surfaces perpendicular to the rolling (RD) and transverse (TD) directions was suggested by Morris *et al.* (1991). Pospiech and Jura (1974) investigated the effect of the range of colatitude angle of pole-figure data on the relative deviation of ODF coefficients for the RD, TD, ND frame. The present paper represents an attempt to evaluate the effect of choice of reference frame on the results obtained by such methods.

PROCEDURE

The "equal-area" pole-figure-data net, illustrated in Figure 1 for the RD, TD, ND frame, corresponds to that used at Armco Research and Technology since 1974 and previously described by Morris (1984). Figure 1 is an equal-area projection of this net on a plane whose normal makes equal angles with RD, TD, ND. The figure illustrates 512 data points in one quadrant of the pole figure. Data were used from four contiguous quadrants in a program imposing no physical symmetry, but the results were sufficiently symmetric that comparison of the same

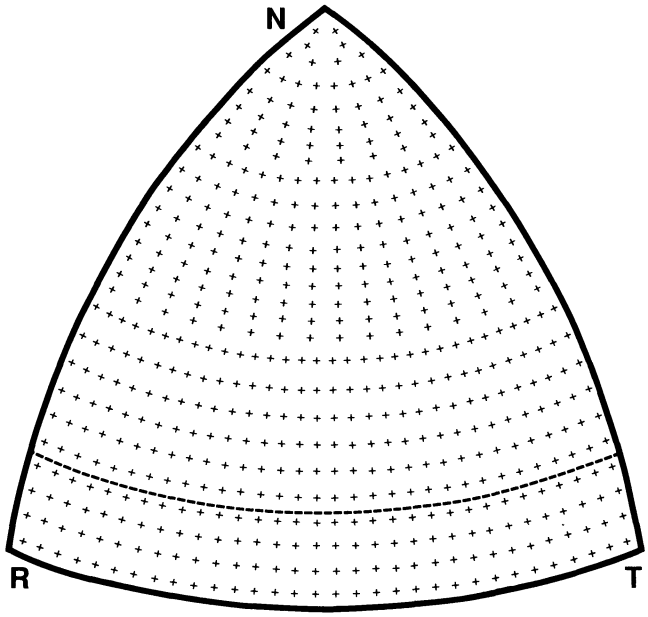

Figure 1 Equal-area projection of "equal-area" pole-figure-data net for sample surface perpendicular to normal (N) direction.

quadrant in each case seems adequate. Data from points below the dotted line were not used in the analysis. Nets for the other two frames may be obtained by rotating the net in Figure 1 respectively 120 and 240 degrees about the normal to the page while the R, T, and N directions remain fixed.

Incomplete {110}, {100} and {112} pole figures for a sheet sample (RD, TD, ND frame) were used with a least-squares procedure (Bunge 1969, 1982, Pospiech and Jura 1974, Morris 1975) to calculate ODF coefficients. These coefficients were transformed to −ND, TD, RD and ND, RD, TD frames according to Roe (1965, 1966). Incomplete {110}, {100} and {112} pole figures were then calculated for each frame and used as input data. The resulting ODF coefficients were transformed to the RD, TD, ND frame in each case and complete pole figures were calculated. Calculated initial (I) {110}, {100} and {112} pole-figures and those obtained from incomplete-pole-figure calculations for the −ND, TD, RD; (R): ND, RD, TD; (T): and RD, TD, ND; (N) frames and $\phi = 45$ degree sections of the ODF are illustrated in Figures 2 through 5. As previously noted, data below the dashed line in Figures 2–4 (I) were not used in calculations yielding Figures 2–5 (N). In the case of the −ND, TD, RD and ND, RD, TD frames, the data net and excluded region correspond to rotating the net in Figure 1 respectively 120 and 240 degrees about the normal to the page while holding R, T and N directions fixed.

CONCLUSIONS

It is apparent that the essential features of Figures 2–5 (I) are faithfully reproduced in Figures 2–5 (R), (T) and (N). This implies that, providing

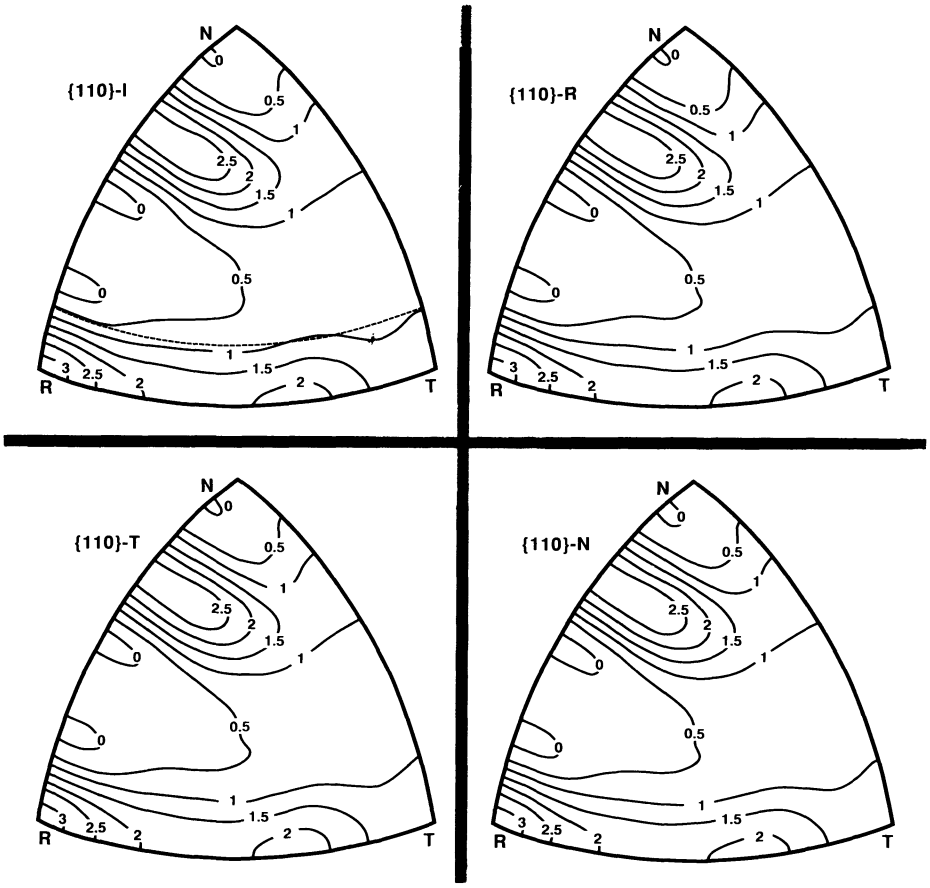

Figure 2 Equal-area projections of initial (I) {110} pole figure and {110} pole figures recovered from surfaces perpendicular to rolling (R), transverse (T) and normal (N) directions.

equivalent crystallite-orientation populations are encountered, samples whose surfaces are respectively perpendicular to the rolling, transverse and normal directions may be expected to yield equivalent results for the present (or equivalent) sampling scheme. Successive reference of the colatitude pole to the rolling, transverse and normal directions and omission of data for which the cosine of the colatitude angle is less than 0.25 (*i.e.* the colatitude angle is greater than 75.5 degrees) has produced equivalent results, using a least-squares procedure in each case.

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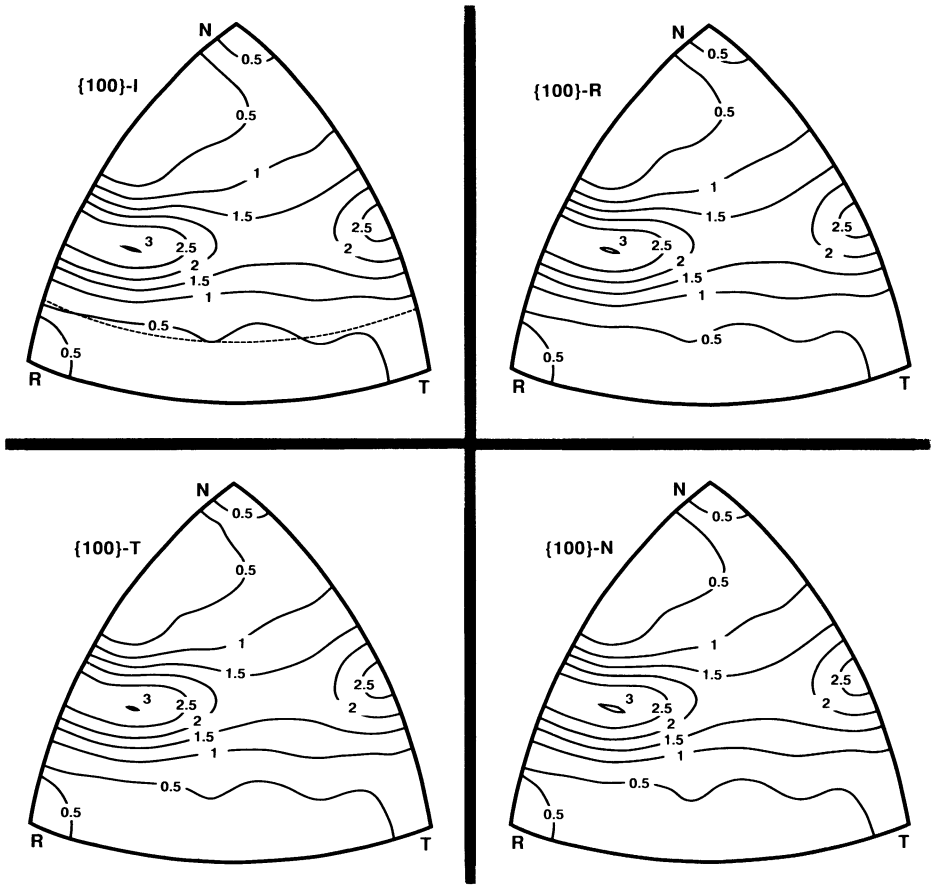

Figure 3 Equal-area projections of initial (I) {100} pole figure and {100} pole figures recovered from surfaces perpendicular to rolling (R), transverse (T) and normal (N) directions.

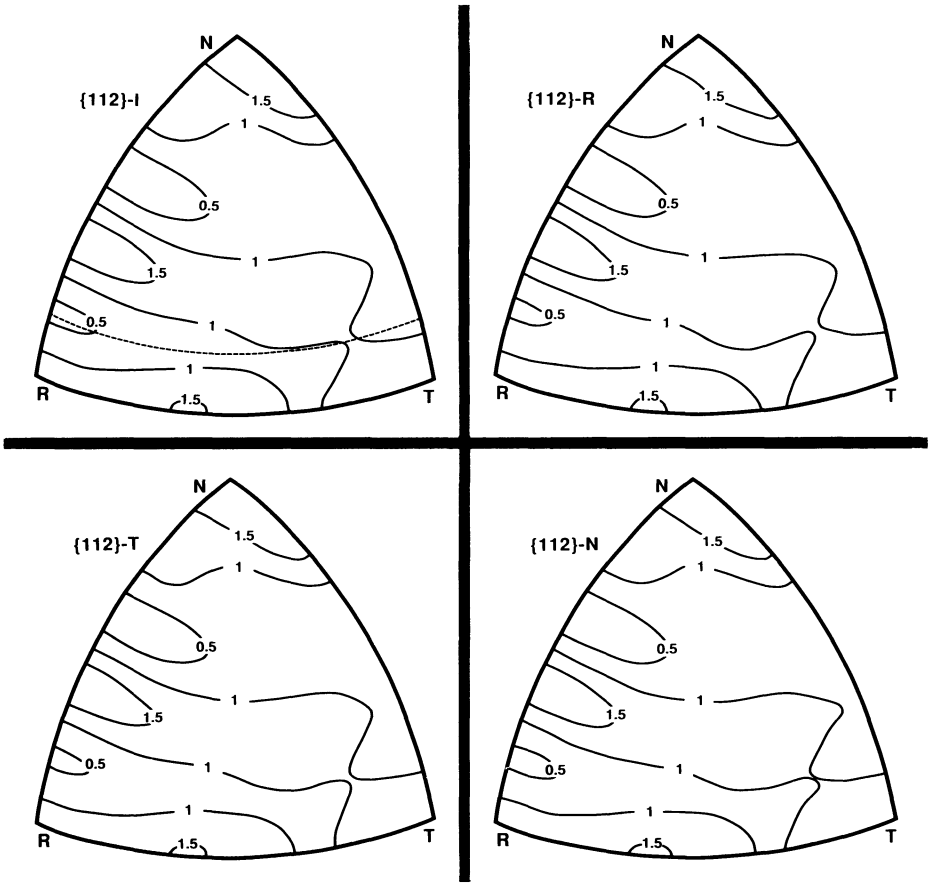

Figure 4 Equal-area projections of initial (I) {112} pole figure and {112} pole figures recovered from surfaces perpendicular to rolling (R), transverse (T) and normal (N) directions.

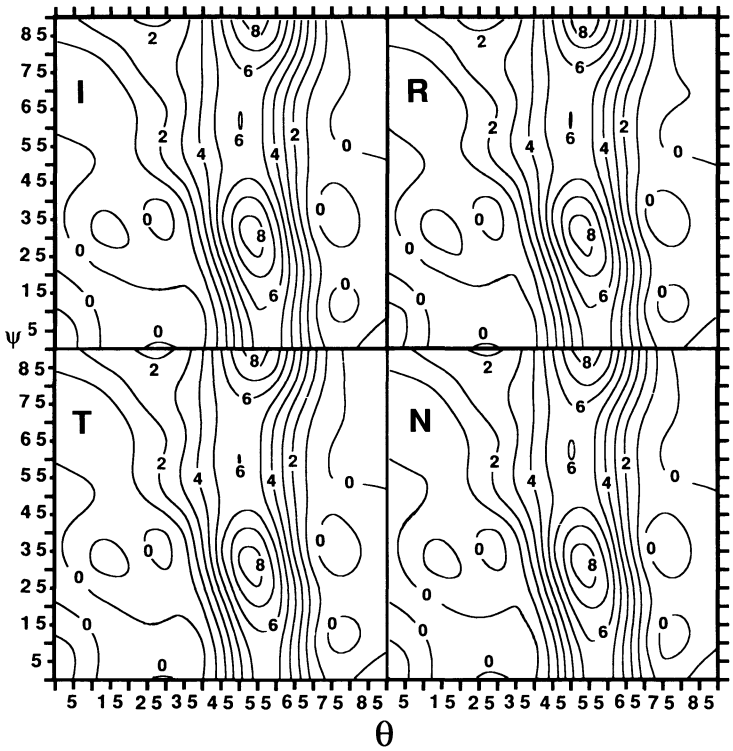

Figure 5 $\phi = 45$ degree sections of crystallite orientation distributions: initial (I); recovered from incomplete-pole-figure data for surfaces perpendicular to rolling (R), transverse (T) and normal (N) directions.

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