HIGH-RESOLUTION PARALLEL-BEAM POWDER DIFFRACTION MEASUREMENT OF SUB-SURFACE DAMAGE BELOW POLISHED SURFACES OF CERAMICS

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High-resolution, grazing incidence parallel-beam powder diffraction has been used to detect the sub-surface damage below alumina surfaces subjected to polishing with cerium oxide or diamond. Experiments were undertaken at the powder diffraction station BM16 at the ESRF, Grenoble. Despite very significant evolution of the surface morphology [1], no changes in the sub-surface strains were observed over a 20 minute period of polishing with ceria. For both polishing materials, the variation with angle of the full width half height maximum (FWHM) was successfully modelled by a strain distribution that fell exponentially with depth. Although the surface amplitude δ_o and depth dependence parameter λ are coupled, we have been able to place upper limits on the depth to which the damage extends. Under realistic assumptions, the depth of damage induced by 1μm diamond paste is comparable to that from 3μm ceria polish [2].

In the case of Al_2O_3/5vol%SiC nanocomposites, the data fitting was sufficiently robust for independent determination of δ_o and λ to be possible. The depth λ^{-1} at which the FWHM fell to 1/e varied from 1.4μm for the ground surface to 480, 360 and 140nm after polishing with 8, 3 or 1μm diamond paste respectively. The values scaled linearly with the depth of dislocation activation determined from direct observation of cross-sections by transmission electron microscopy. The maximum FWHM at the surface also fell monotonically as the polishing particle diameter was reduced. Annealing of the ground nanocomposites resulted in a fall in the maximum FWHM and a slower rate of decrease of the FWHM with depth. This reduction in the random strain level at the surface is consistent with the observed reduction in surface dislocation density. No changes were observed in the FWHM distribution on annealing polished nanocomposites.

[1] I Pape, C W Lawrence, S G Roberts, G A D Briggs, O V Kolosov, A W Hey, C F Paine and B K Tanner, Phil Mag A **80** (2000) 1913-1934

[2] B K Tanner, T P A Hase and H Z Wu, Phil. Mag. Letts. (2001) in press