Figure 1.- Schematic illustration of the different types of cracks that may be produced by sharp indentation. (a) Berkovick indentation with radial cracks emerging from the corners of the imprint. Indentation size is labelled as \(a\), crack length at the surface is labelled as \(l\), and the sum of both quantities as \(c\). (b) Vickers cracks, with dimensions following the same labelling as before. (c) Cross-sectional view of a sharp indentation showing semi-elliptical cracks. (d) Median cracks emanating from underneath the indenter and propagating outwards (e) Palmqvist cracks. Observe that they will produce the same radial cracks at the surface than the semi-elliptical cracks (f) lateral cracks which may be not be appreciated at the surface.

Figure 2.- SEM images of cube-corner indentations on (a) Soda-lime glass at 50 mN, (b) Si (100) at 20 mN, (c) SiC-6H (0001) at 50 mN, d) WC prismatic plane at 200 mN (e) and YSZ at 50 mN. In all cases, radial cracks can be appreciated emanating from the corners of the imprint.

Figure 3.- Crack morphology system for a cube-corner indentation in soda-lime glass using FIB tomography at 5 mN, 10 mN, 20 mN, 50 mN and 100 mN. Both the crack and the nanoindentation imprint have been reconstructed. As the load increases, the cracks increase in relative length and lateral cracks appear. Observe that the inelastic deformation zone underneath the imprint hinders the propagation of cracks due to the compressive residual stresses, but as crack progresses this zone decreases in relative size.

Figure 4.- Crack morphology of a cube-corner indentation on Si (100) at 20 mN using FIB tomography. Crack is deflected as it propagates away from the indentation, probably due to the effects of crystallography.

Figure 5.- Crack morphology of a cube-corner indentation on SiC-6H (0001) at 50 mN. A large lateral crack is observed, in addition to the radial cracking.

Figure 6.- Crack morphology of a cube-corner indentation on YSZ (100) at 70 mN.

Figure 7.- Crack morphology of a cube-corner indentation on a WC grain of a WC-Co composite at 200mN. Radial cracks emanating from the indentation corners and radial cracks at cleavage planes are appreciated. Cross sectional views show that the cracks are of Palmqvist cracks due to relative high toughness of the WC grain.

Figure 8.- Comparison between \(K_c\) values computed using Anstis et al. equation (full symbols) and Laugier equation (open symbols) with the values found in the literature (values obtained with conventional methods such as SENB).
Fig 2

(a) glass, 50 mN

(b) Si, 20 mN

(c) SiC, 50 mN

(d) WC-Co, 200 mN

(e) YSZ, 50 mN
Fig 3

Front view  Top view  Lateral view

5 mN

1 μm

10 mN

2 μm

20 mN

2 μm

50 mN

3 μm

100 mN

5 μm
Fig 4

Front view  Top view  Lateral view

2 μm
Fig 6

Front view  Top view  Lateral view

4 μm
Fig 7

Front view  Top view  Lateral view

4 µm
Figure 8

Laugier equation

Soda-lime glass
Si (100)
SiC-6H (0001)

Anstis et al. equation

Soda-lime glass
Si (100)
SiC-6H (0001)