Deformation and fracture of single crystal 4H-SiC
Supporting Information

Determination of area moment of inertia (cross-sectional secondary moment)

This supporting information describes the method to determine the area moment of inertia (the cross-sectional secondary moment) of a beam specimen having a pentagonal section profile. Fig. S1 exhibits a schematic illustration for the (*x, y, z*) coordinates of a microcantilever bean specimen with the centroid and neutral axis. Since a load is applied in the *y*-axis direction, the bending strength is calculated using the area moment of inertia, I_{Gx} ("*I*" in the main text) with respect to the neutral axis parallel to the *x*-axis. In this study, we employed a method using the trapezoidal approximation as follows.

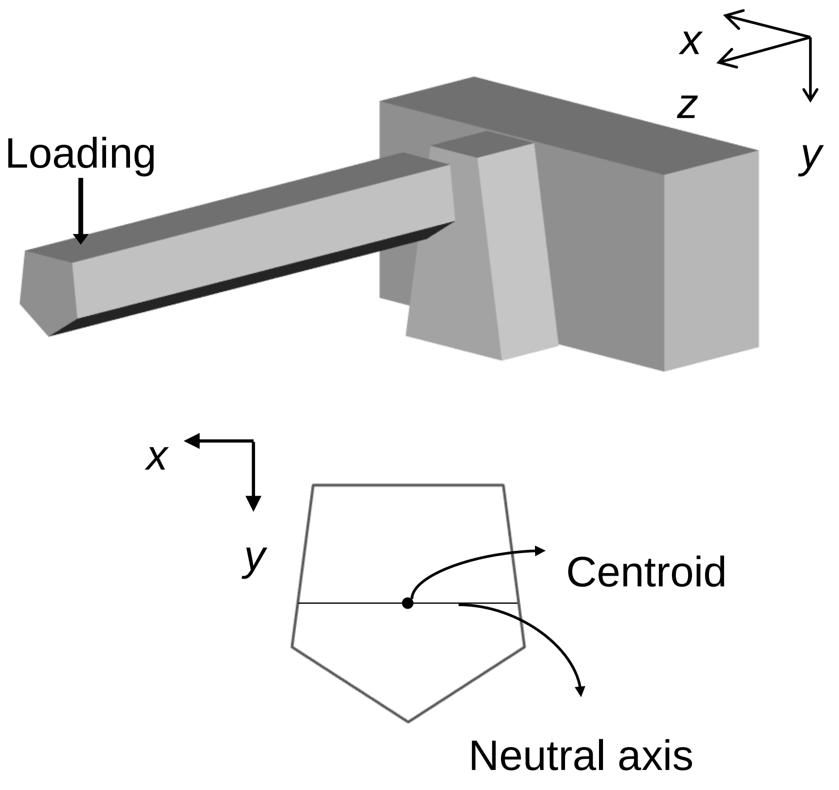
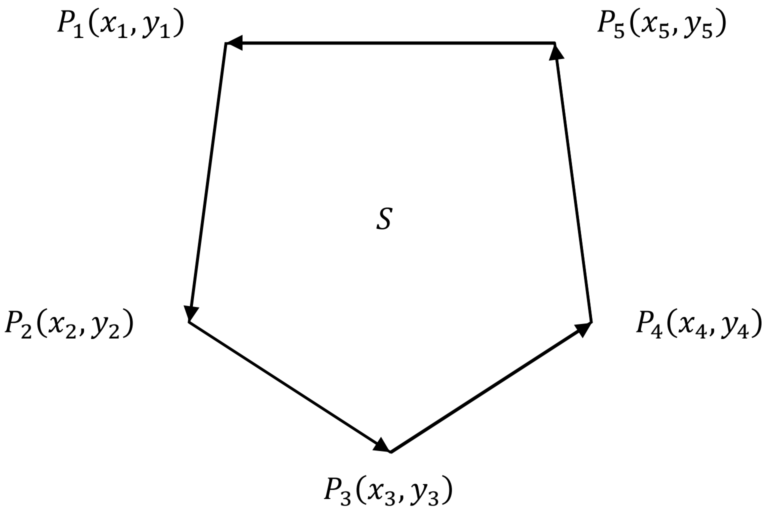


Figure S1. Schematic illustration of the (*x, y, z*) coordinates of a microcantilever bean specimen having a pentagonal section profile with the centroid and neutral axis.

[1] Determine the coordinates, $P_1 \sim P_5$. of the five vertexes of the pentagon from the SEM image of the front view of the specimen.



[2] Calculate the total area of the pentagon, S, using the coordinates, $P_1 \sim P_5$.

$$S = \frac{1}{2}\sum_{i=1}^{5}(x_i - x_{i+1})(y_i + y_{i+1}) \qquad (x_6 = x_1, y_6 = y_1) \qquad \text{(S1)}$$

[3] Calculate the centroid coordinates of each approximated trapezoid, (x_{Gi}, y_{Gi}), i=1~5, using the coordinates, $P_1 \sim P_5$.

$$x_{Gi} = \frac{\dfrac{(2x_{i+1} + x_i)y_{i+1} + (x_{i+1} + 2x_i)y_i}{3}}{y_{i+1} + y_i} \qquad y_{Gi} = \frac{\dfrac{y_{i+1}^2 + y_i y_{i+1} + y_i^2}{3}}{y_{i+1} + y_i} \qquad \text{(S2)}$$

[4] Calculate the centroid coordinates of the pentagon, (x_G, y_G), by summing the products of each trapezoid's centroid coordinates, (x_{Gi}, y_{Gi}), and its area, S_i, and dividing them by the total area, S.

$$x_G = \frac{1}{S}\sum_{i=1}^{5} x_{Gi} S_i \qquad y_G = \frac{1}{S}\sum_{i=1}^{5} y_{Gi} S_i \qquad \text{(S3)}$$

[5] Calculate the area moment of inertia, I_x and I_y of the x- and y-axes using the coordinates, P_1~P_5.

$$I_x = \sum_{i=1}^{5} I_{xi} \qquad I_{xi} = \frac{\left(y_{i+1}^2 + y_i^2\right)\left(y_{i+1} + y_i\right)\left(x_{i+1} - x_i\right)}{12}$$
$$I_y = \sum_{i=1}^{5} I_{yi} \qquad I_{yi} = \frac{x_{i+1}^3 y_{i+1} - x_i^3 y_i}{4} + \frac{\left(x_{i+1} y_i - x_i y_{i+1}\right)\left(x_{i+1}^2 + x_{i+1} x_i + x_i^2\right)}{12} \qquad \text{(S4)}$$

[6] Calculate the area moment of inertia, I_{Gx}, with respect to the neutral axis from the total area, S, the centroid coordinate, y_G, and the area moment of inertia, I_x.

$$\boxed{I_{Gx} = I_x - y_G^2 S} \qquad I_{Gy} = I_y - x_G^2 S \qquad \text{(S5)}$$