**Supplementary material:**

****

**FIG. S1.** Schematic illustration of decomposition of non-equibiaxial residual stress, and influences of residual stress on load-depth curves and remnant indentation.



**FIG. S2.** 3D finite element model and mesh for simulation of spherical indentation on stressed sample.



**FIG. S3.** Influence of normalized indentation depth on the asymmetry of remnant indentation for typical materials under the same residual stress ( and ).



**FIG. S4.** Variation of the asymmetry of remnant indentation with the normalized shear stress part under various equibiaxial stress parts for different materials: (a)  and , (b)  and , (c)  and , (d)  and , (e)  and , (f)  and , (g)  and , (h)  and , and (i)  and .



**FIG. S5.** The indentation load-depth curves for the same material (, ) under residual stresses (a) with various equibiaxial stress parts and identical shear stress part, and (b) with identical equibiaxial stress part and various shear stress parts.



**FIG. S6.** The bilinear relation between the relative load change and the normalized equibiaxial stress for materials with a constant yield strain of (a) 0.005, (b) 0.007 and (c) 0.009 and different strain-hardening exponents. These materials were subjected to equibiaxial stresses, namely the shear part equals to 0.