Supplementary information for

Effective modulus of particle-packing containing hard and soft particles

Om Prakash Bamboriya and Mahesh S Tirumkudulu
Department of Chemical Engineering, IIT Bombay, Mumbai 400076, INDIA

Mahesh S Tirumkudulu
Email: mahesh@che.iitb.ac.in

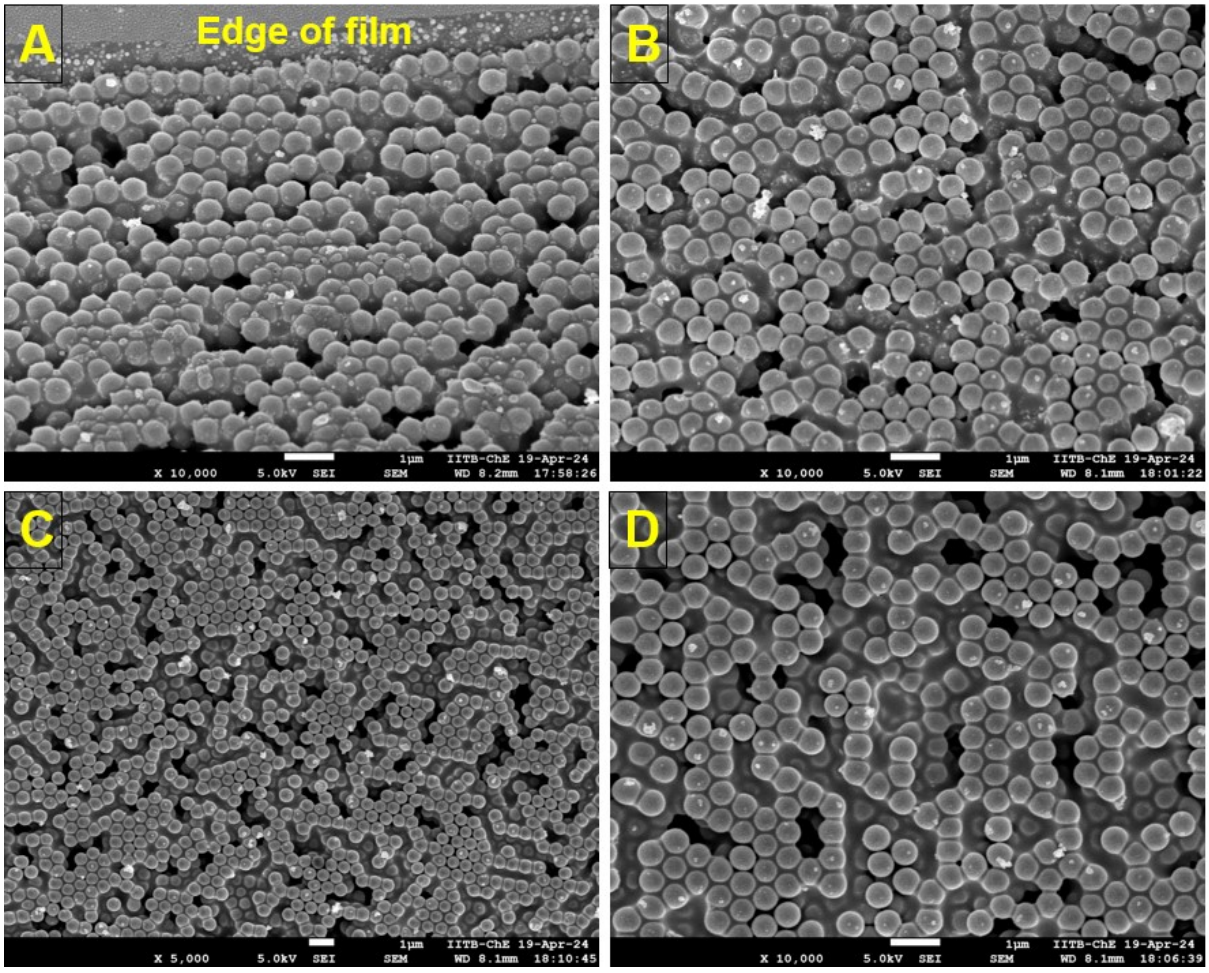

Fig. S1 SEM images of the top section of the film after heating at 200°C for 60 minutes. PS particles are completely deformed, while silica particles are as it is spherical. Images show particle packing at the edge of the film (A), close to the edge of the film (B), and the centre of the film (C). The zoomed view of the centre of the film is shown in (D).

The Hertzian contact model was fit to the loading curve of the force versus penetration depth profile. The indentation was performed for different ratios of silica and PS particles in the drying film. Note that the silica particle volume fraction is given by,

$$\alpha = \frac{Silica\ particle\ volume}{Total\ particle\ volume}$$

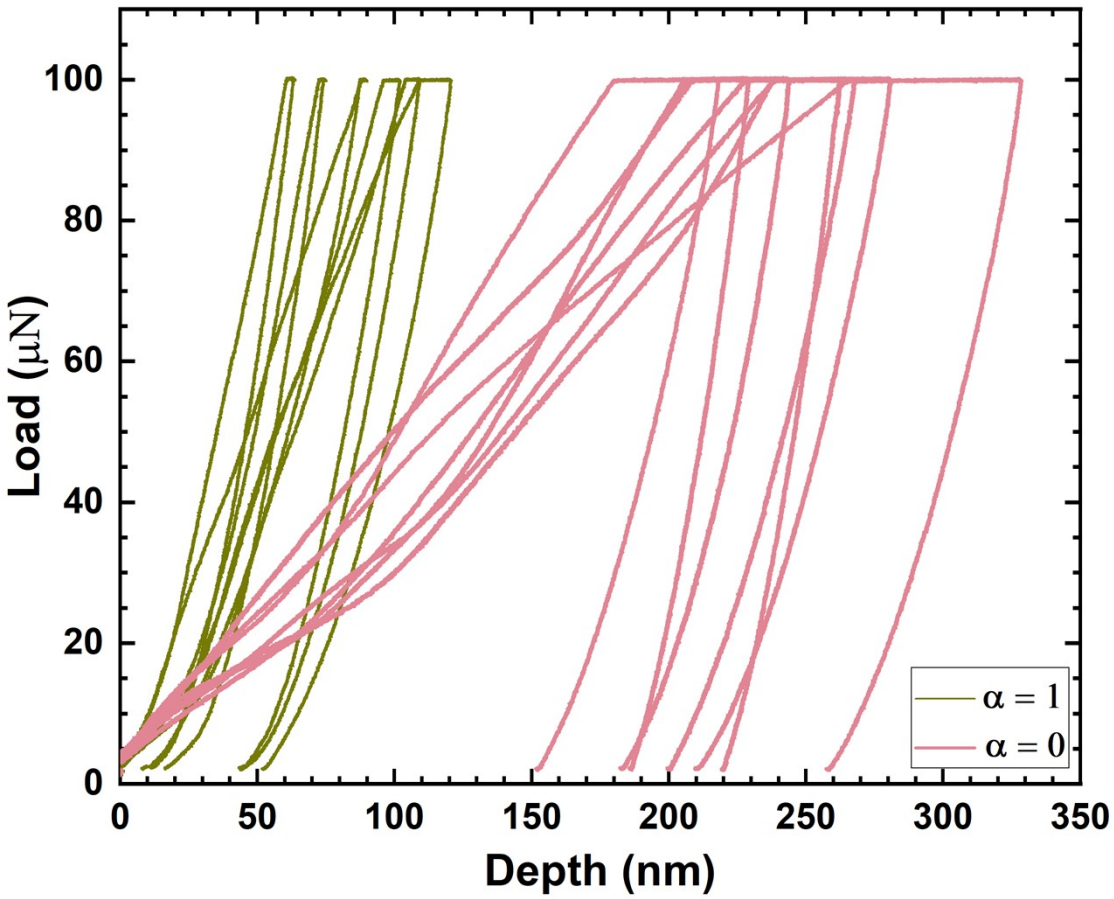

Fig. S2 Comparison between pure silica particle film ($\alpha = 1$) and pure PS particle film ($\alpha = 0$). Each line indicates the indentation test performed at different locations of the film. In all cases, the load is increased from 0 to 100 μN load in 20 s, held at the maximum load for 20 s followed by unloading from 100 μN to 0 μN in another 20 s. The penetration depth is low (<100 nm) for pure silica particle film while depth is high (175-300 nm) for pure PS particle film.

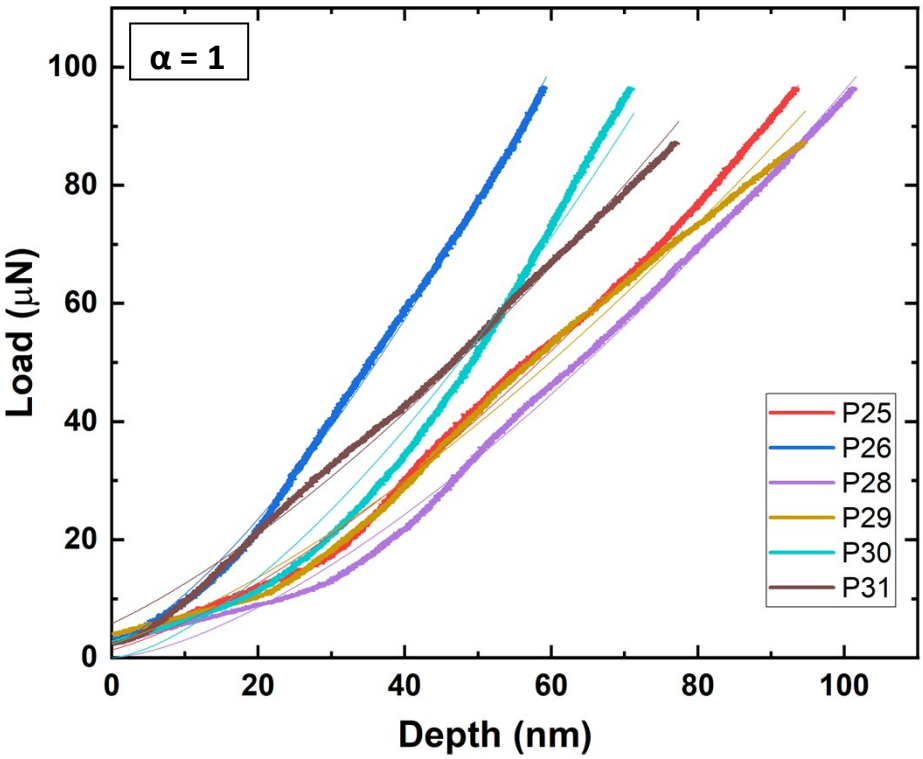

Fig. S3 Hertzian contact model is fit to the initial loading curve for pure silica film (α = 1).

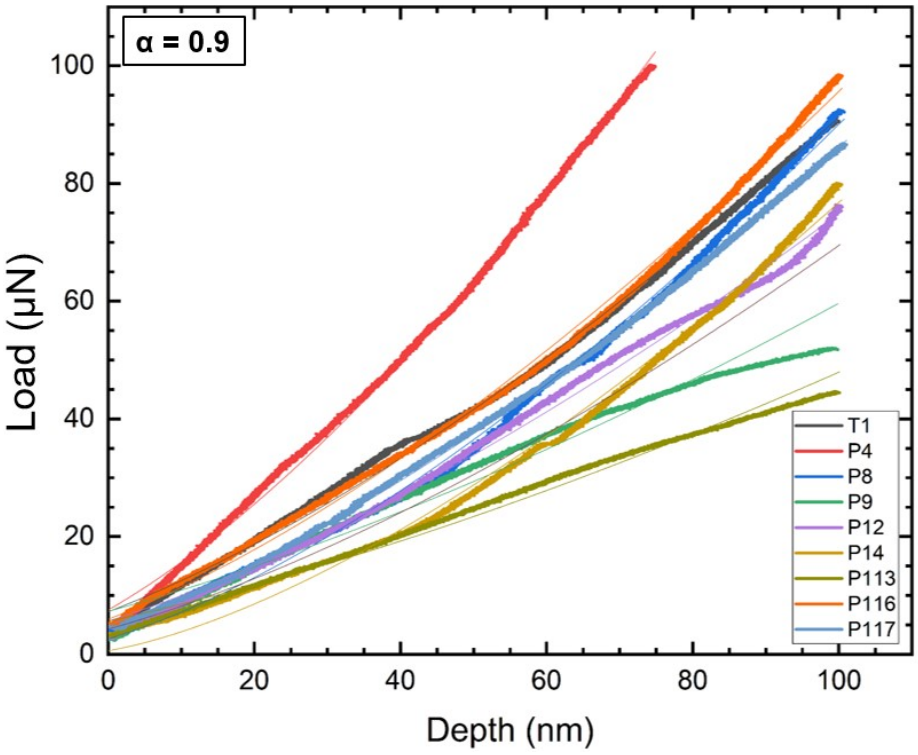

Fig. S4 Hertzian contact model is fit to the initial loading curve for α = 0.9.

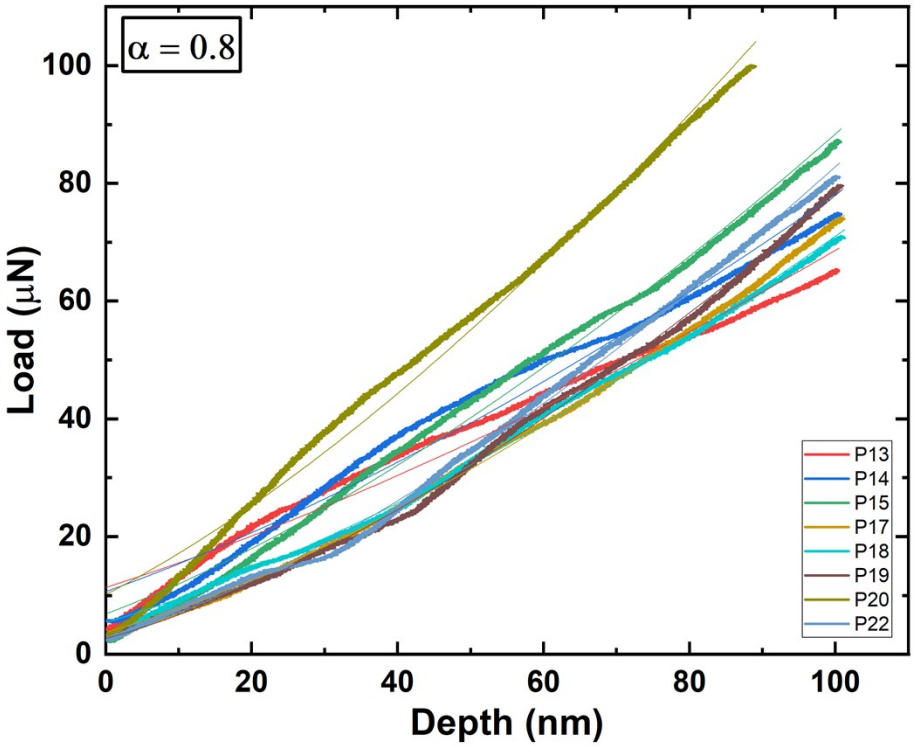

Fig. S5 Hertzian contact model is fit to the initial loading curve for α = 0.8.

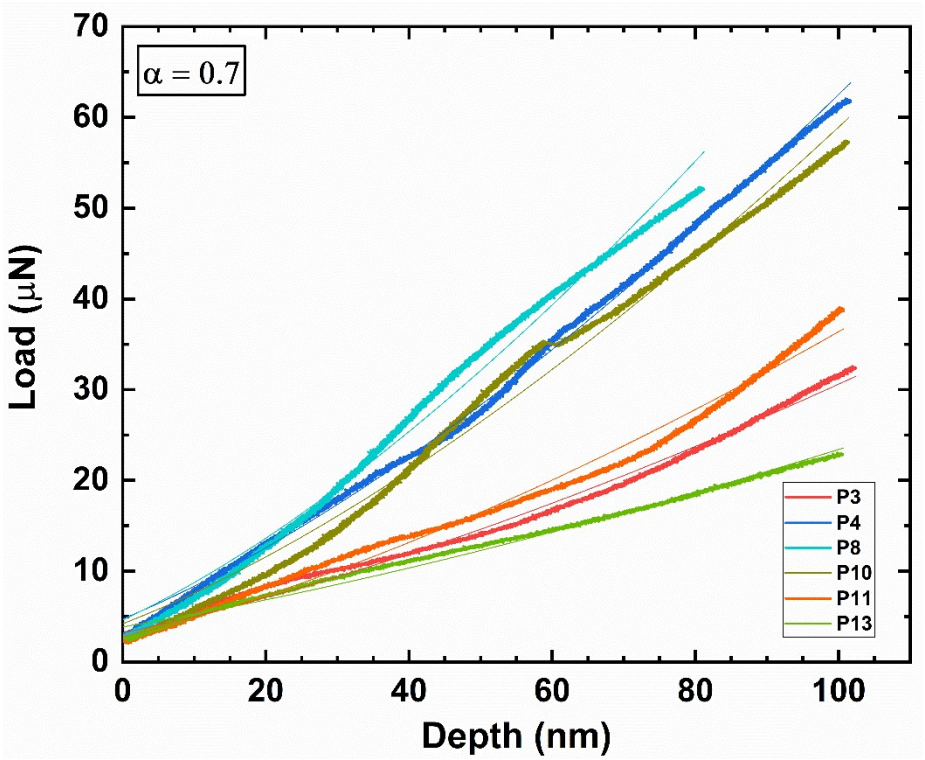

Fig. S6 Hertzian contact model is fit to the initial loading curve for α = 0.7.

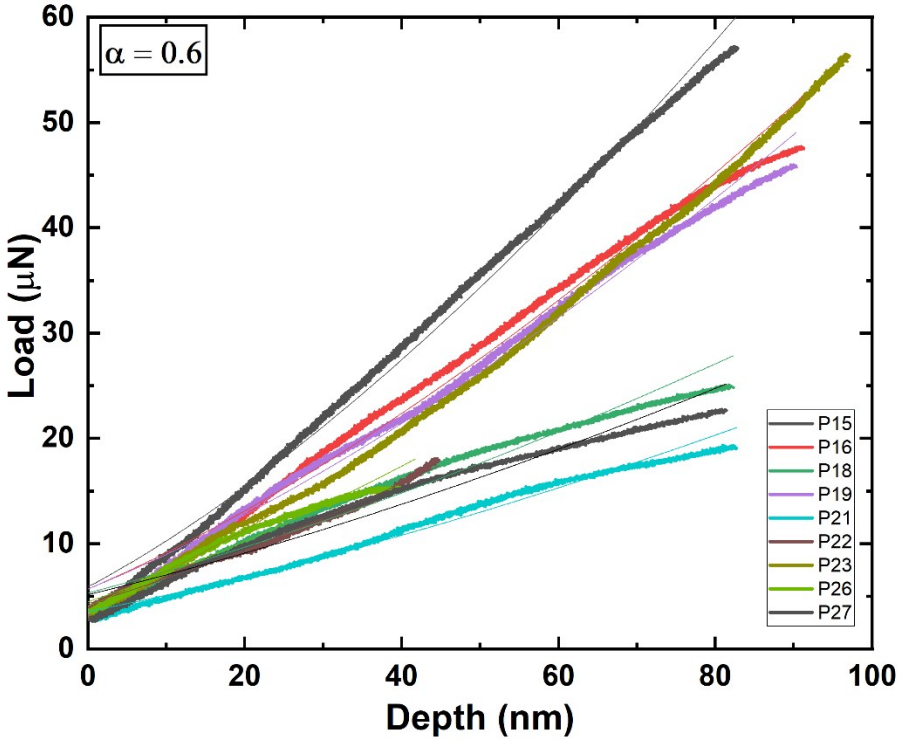

Fig. S7 Hertzian contact model is fit to the initial loading curve for α = 0.6.

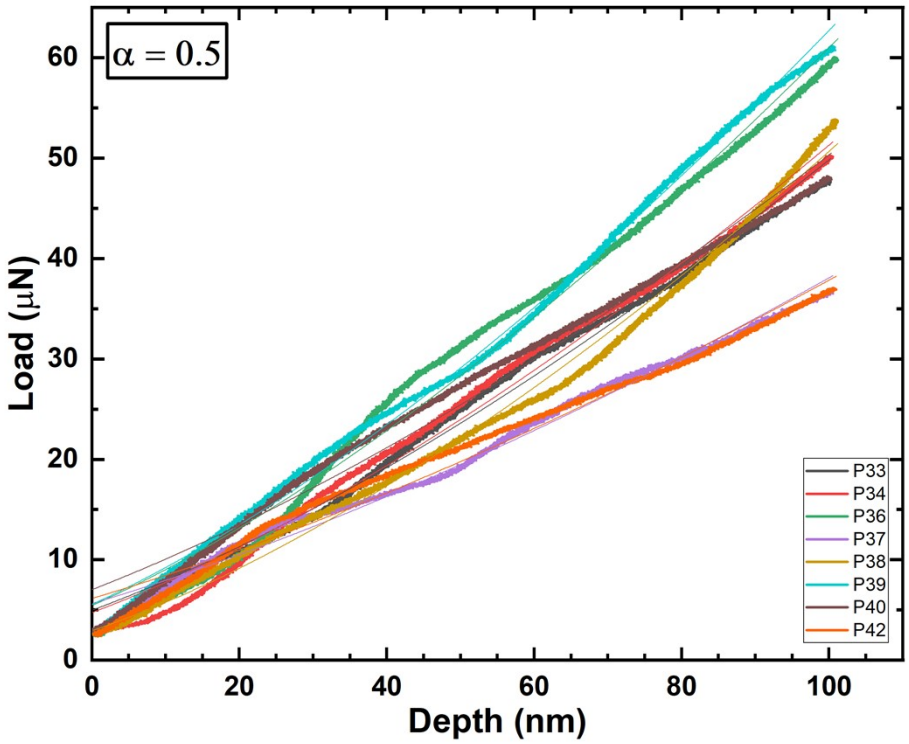

Fig. S8 Hertzian contact model is fit to the initial loading curve for α = 0.5.

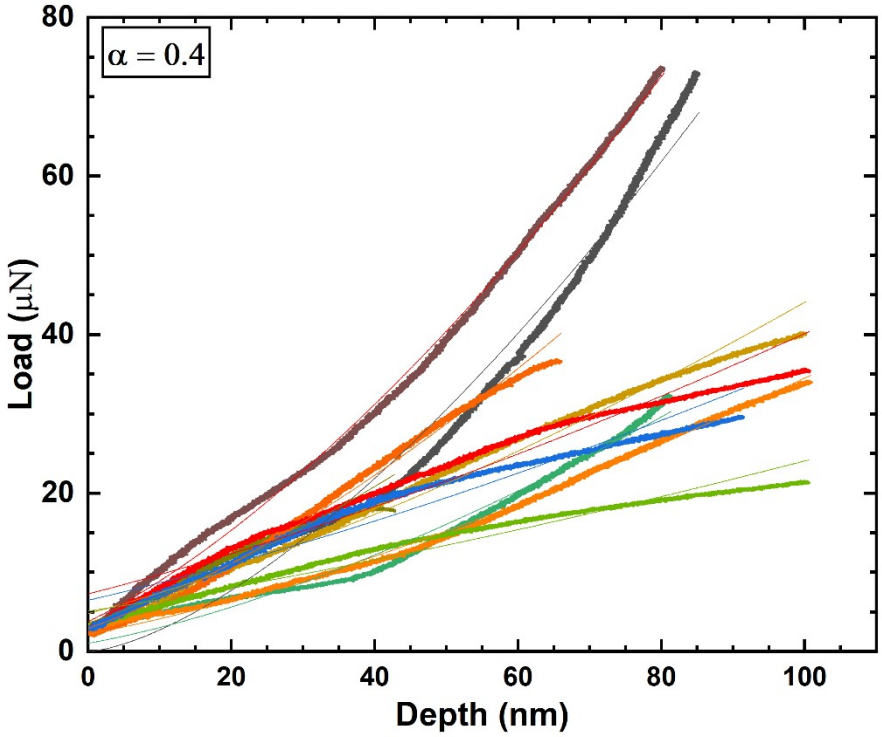

Fig. S9 Hertzian contact model is fit to the initial loading curve for α = 0.4.

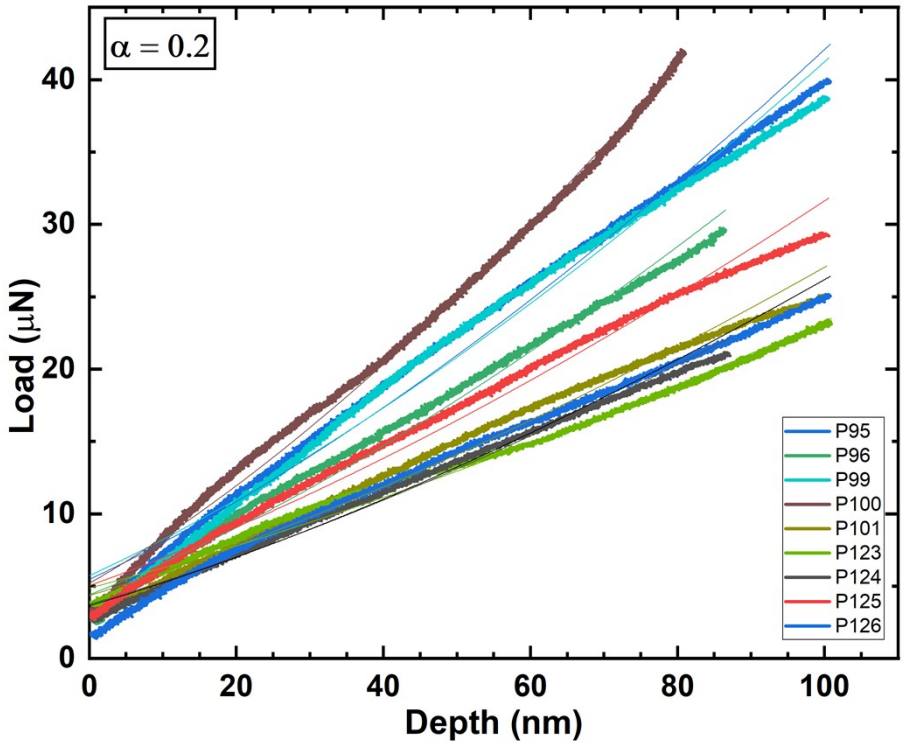

Fig. S10 Hertzian contact model is fit to the initial loading curve for α = 0.2.

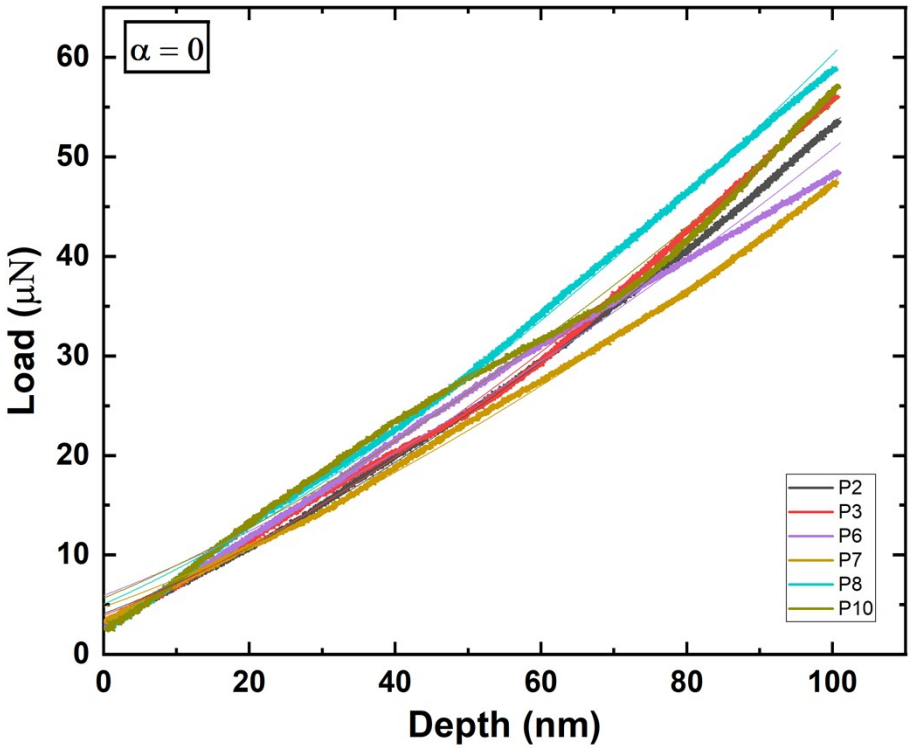

Fig. S11 Hertzian contact model is fit to the initial loading curve for α = 0.