Poster Presentation

MS047.P13

Single crystal alumina under nanoindentation: Loading rate effect

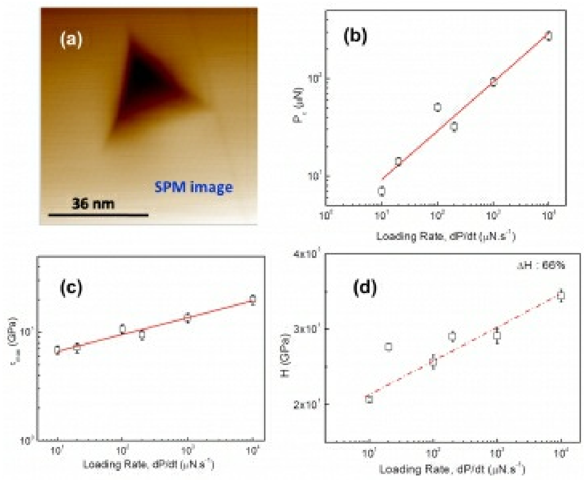
Manjima Bhattacharya[1], Arjun Dey[2], Anoop Mukhopadhyay[3]

[1]*Department Of Chemical Sciences, Indian Institute Of Science Education And Resea, Kolkata, India,* [2]*Thermal Systems Group, ISRO Satellite Centre, Vimanapura Post, Bangalore- 560 017, India, Bangalore, India,* [3]*Advanced Mechanical and Materials Characterization Division, CSIR-Central Glass and Ceramic Research Institute, Kolkata- 700 032, India, Kolkata, India*

E-mail: mbmanjima7@gmail.com

Sapphire is a single crystal form of alumina in the purest form with no porosity or grain boundaries, making it theoretically dense. There is an increasing demand in airborne applications and UAVs for large sapphire windows capable of hosting various equipment sets, working at different wavelengths under its coverage that combines high optical transmission, low transmitted wavefront distortion and outstanding mechanical strength properties at high and low temperatures. However, they are vulnerable to nanoscale contact induced static and dynamic damages. The present work therefore reports the nanomechanical properties of a single crystal alumina or sapphire as a function of variations in loading rates e.g., 10-10000 microN.s-1. The nanohardness (H) of sapphire shows significant enhancement of ~ 66% from about 20 to 34 GPa with the variation in loading rates. The load-depth plots reveal the presence of multiple micro-pop-in and micro-pop-out events which signify the occurrences of nanoscale plasticity events in the sapphire under nanoindentation. The critical load (Pc) i.e., the load at which nanoscale plasticity events initiate increases with the loading rates. This result implies an inherent capability of sapphire to increase its intrinsic contact deformation resistance the more quickly we try to deform it. These results are explained in terms of the maximum shear stress (τmax) generated underneath the nanoindenter.

[1] Bhattacharya M. et al. (2016) Ceram. Int. 42, 13378-13386.
[2] Bhattacharya M. et al. (2016) Mater. Res. Exp. 3, 045017.
[3] Bhattacharya M., et al. (2013) Ceram. Int. 39, 999 -1009.



Keywords: nanoindentation, sapphire, nanohardness