Type of presentation: Poster

**MS-5-P-2515 Transmission electron microscopy investigation of transparent α-alumina**

Nabiei F.[1], Tewari A.[2], Cantoni M.[1], Bowen P.[2], Hebert C.[1]

[1]Interdisciplinary Centre for Electron Microscopy, EPFL, Lausanne, Switzerland, [2]Powder Technology Laboratory, EPFL, Lausanne, Switzerland

Email of the presenting author: farhang.nabiei@epfl.ch

Transparent polycrystalline alumina is being promoted as a replacement for sapphire because of its excellent mechanical and high temperature properties as well as the possibility to form different shapes. Transparency in this material is only achievable by controlling porosity and grain growth which is usually done by doping. Computational studies have been done on these materials to simulate dopant segregation at the grain boundaries (e.g. Tewari et al. 2012, Galmarini et al. 2011); however, there is lack of experimental analysis to quantify the dopant concentration in the grain boundaries and validate the modelling which could then be used as a predictive tool.

In this study α-alumina doped by 445 ppm of La and Y and sintered by spark plasma sintering (Stuer et al. 2009) is used to investigate dopant segregation at grain boundaries with different orientations. Thin sections about 300nm thick were made by focused ion beam (FIB) for investigation by transmission electron microscopy (TEM).

Energy dispersive X-ray (EDX) spectroscopy shows strong cosegregation of La and Y atoms to all grain boundaries observed. This is in agreement with atomistic simulation where no energetic gain or loss for cosegregation over single dopant segregation was predicted. EDX quantification on individual grain boundaries showed the average of 2.79 atoms/nm$^2$ and 2.29 atoms/nm$^2$ for Y and La respectively which is in a good agreement with the optimum total dopant concentrations found in simulations 4-6 atoms/nm$^2$ (Tewari et al. 2012). Also, we detected Cl segregation in grain boundaries and triple points.

Finally, large angle convergent beam electron diffraction (LACBED) is performed to characterize the grain boundaries studied by EDX. By using LACBED to identify the planes parallel to the grain boundary in each adjacent grain, the angle between these planes can be calculated. It was found that the grain boundaries studied here were all high angle ones (e.g. (-7, -2, 4) & (1, 5, 5)). This data was used to simulate the same grain boundary for direct comparison between simulations and experimental results for dopant segregation. It was found that in contrast to the twin grain boundaries, which favor lower order GB complexions, general grain boundaries favor higher order grain boundary complexions. It would also lead to higher grain growth in general grain boundaries in comparison to twin grain boundaries.

Tewari, A., Galmarini, S., Stuer, M., Bowen, P., 2012. . Journal of the European Ceramic Society 32, 2935–2948.

Galmarini, S., Aschauer, U., Tewari, A., Aman, Y., Van Gestel, C., Bowen, P., 2011. . Journal of the European Ceramic Society 31, 2839–2852.

Stuer, M., Zhao, Z., Aschauer, U., Bowen, P., 2010. . Journal of the European Ceramic Society 30, 1335–1343.

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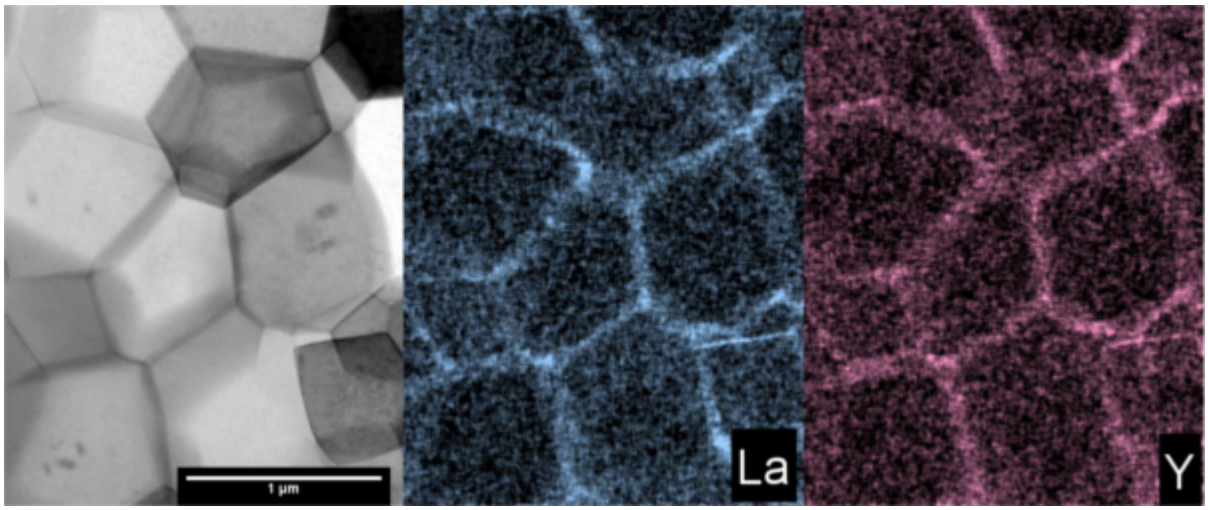


Fig. 1: From left to right: bright field image of La ,Y codoped alumina, La intensity map and Y intensity map.

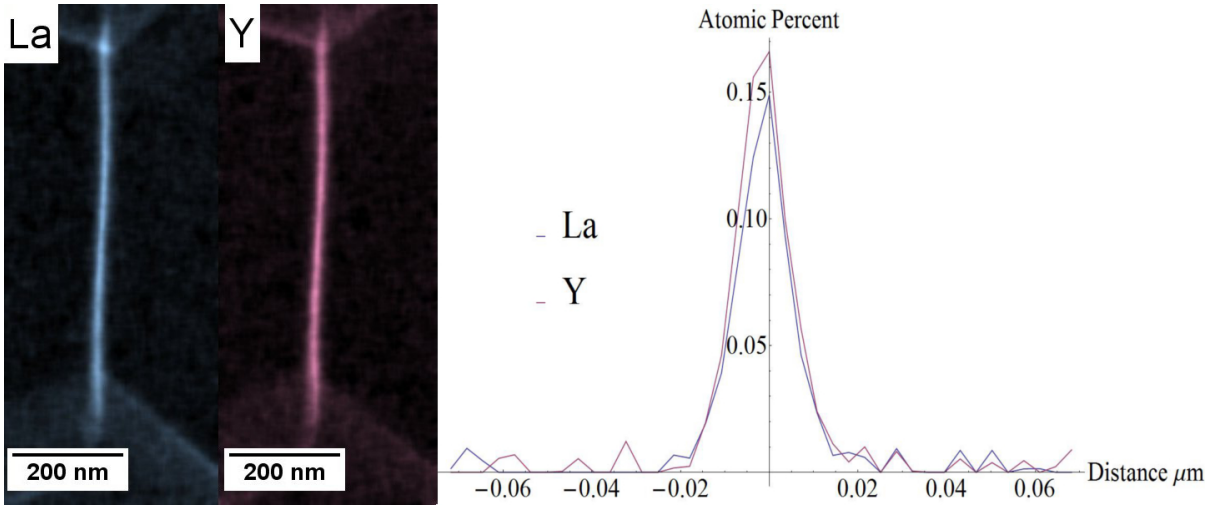


Fig. 2: From left to right: La intensity map, Y intensity map and normal line scan on one grain boundary in La, Y codoped alumina.

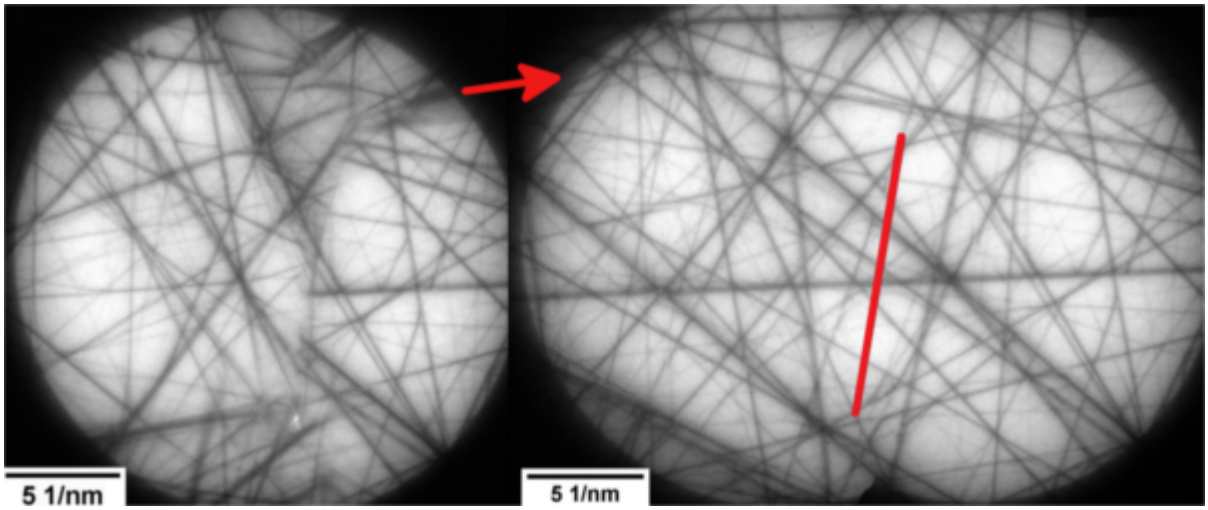


Fig. 3: LACBED pattern from a grain boundary (left) and one of its grains (right). Grain boundary direction (known from the left pattern) is shown with red line in the right pattern.