Elemental adsorption at the solid/substrate interface and its effect on heterogeneous nucleation

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In order to understand elemental adsorption at the liquid/inclusion interface and its effect on heterogeneous nucleation, the solid/substrate interface is investigated using high resolution transmission electron microscopy, with particular focus on the surface of inclusions commonly present in recycled alloys, and the competition for nucleation between different inclusion particles.

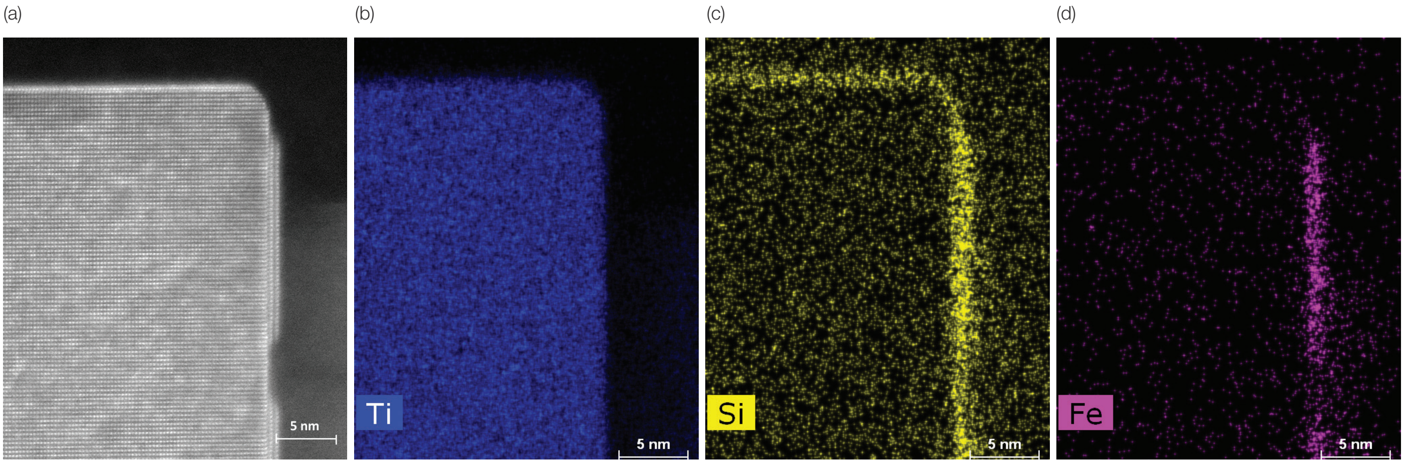

FIGURE 1. (a) HAADF image reveals the atomic arrangement at the surfaces of TiB_2 particle. (b) to (d) EDS maps reveal atomic adsorption layers at the surfaces of TiB_2 particle and that the adsorption layers are Fe-rich and Si-rich, with Fe atoms on prismatic planes and Si on both basal and prismatic planes.

The knowledge created will advance the understanding of the heterogeneous nucleation mechanism, which will be exploited for high performance alloy development for closed-loop recycling and resource efficient manufacturing technologies.

An example is the investigation on the adsorption on the surface of a novel grain refiner based on Al-3TiB_2 master alloy system with the addition of silicon and iron, developed at Brunel University London, and the investigation into the mechanism of grain refinement. The interface between α-aluminium and TiB_2 grain refiner modified by the addition of silicon and iron is characterised using HRTEM and high spatial resolution EDS in order to determine the distribution of Fe and Si (Figure 1). It is found that the adsorption of Fe and Si atoms on the surface of TiB_2 particles occurs, in the form of atomic layers.

Si atoms segregate on TiB_2 surfaces, including both basal and prismatic planes. Fe atoms are adsorbed only on the surface of prismatic plane of the boride particles. Fe adsorption at prismatic plane extends to double atomic layers, which have a larger d-spacing than that of (10-10) TiB_2.

Future research will focus on correlating the segregation with the heterogeneous nucleation and grain refinement mechanisms.