Type of presentation: Poster

IT-7-P-1394 An in-situ transmission electron microscopy study on room temperature ductility of TiAl alloys with fully lamellar microstructure

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Gamma titanium aluminides (TiAl) have gained great interest for research on high-temperature applications due to their weight saving in combination with excellent high temperature properties such as creep and oxidation resistance. However, their poor room temperature ductility and machinability have hindered their application in areas such as aerospace and automobile products. In this study, mechanical properties of newly-developed TiAl alloys were investigated. The new TiAl alloys contain less aluminum compared with conventional gamma TiAl alloy to improve processibility and machinability. Especially, room temperature ductility of fully lamellar TiAl alloys was acquired without heat-treatment or TMP process.Adding beta stabilizers and lowering Al contents in conventional gamma-based TiAl alloys were found to be beneficial for room temperature ductility of TiAl alloys. An in-situ transmission electron microscopy study was conducted at room temperature in order to understand an underlying mechanism on room temperature ductility of TiAl alloys. From in-situ straining transmission electron microscopy experiments, it was revealed that the crack path is different between the TiAl alloys with/without room temperature ductility. The crack in TiAl alloys having room temperature ductility interacted with lamellae by forming bridging ligaments between the two alpha lamellae and the gamma lamellae (Fig. 1). In contrast, the cracks in TiAl alloys without room temperature ductility propagated along grain (colony) boundaries showing brittle intergranular fracture (Fig. 2). Finally, we proposed the important microstructural factors to have room temperature ductility of TiAl alloys.

Acknowledgement: This work was supported by the Fundamental R&D Program of the Korea Institute of Materials Science.

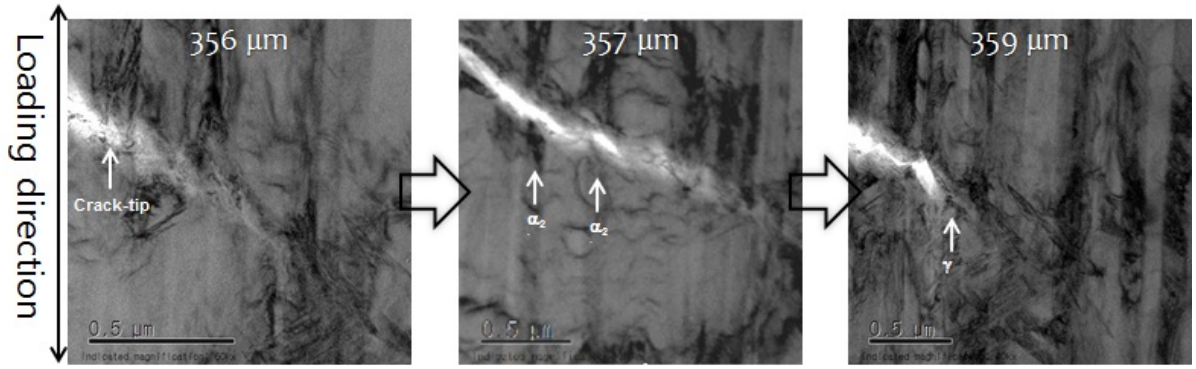

Fig. 1: Bright field images of alloy having room temperature ductilitytaken during in-situ TEM experiment.

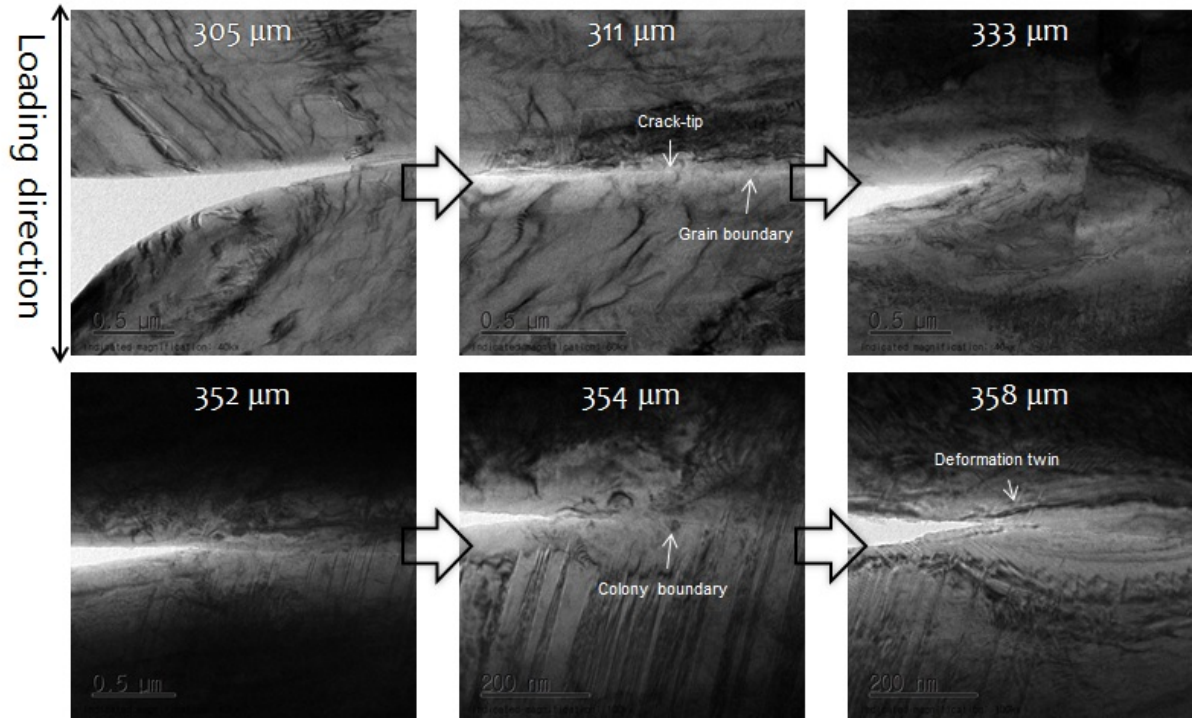

Fig. 2: Bright field images of alloy having no room temperature ductility taken during in-situ TEM experiment.