Thermal stability of CVD grown TiAlN in TiAlN - kappa alumina coatings

Bäcke, O.[1], Petterson, H.[1], Kummel, J.[2], Janssen, W.[2], Stiens, D.[2], Manns, T.[2] and Halvarsson, M.[1]

[1] Chalmers University of Technology, Sweden, [2] Walter AG, Germany

TiAlN is today a common choice for wear-resistant coatings on cutting tools used for metal machining due to its high hardness and excellent oxidation resistance. For long, physical vapour deposition (PVD) has been the standard method for producing commercial available TiAlN coatings. Using PVD it has been impossible to reach Ti(1-x)AlxN coatings with a higher Al content than x = 0.65. A few years ago however a new low pressure chemical vapour deposition (CVD) technique was developed that makes it possible to deposit Ti(1-x)AlxN coatings with a very high Al content, x = 0.9.[1] These high Al content TiAlN coatings show improved hardness compared to other TiAlN coatings and commercially available CVD grown TiAlN coatings are just reaching the market. Wear-resistant coatings often combine layers of different materials to improve properties, where one common choice is alumina. It is thus of interest to investigate if CVD grown TiAlN can be combined with other materials in multi-layered coatings. However, TiAlN is metastable and will under prolonged exposure to high temperatures decompose into h-AlN and cubic TiN, which is detrimental for the performance of a TiAlN coating. Thus any attempt to in cooperate TiAlN in multi layered coatings raises the risk of TiAlN decomposing when exposed to the elevated temperatures necessary to grow other layers in the coating.

In this work, the focus has been on investigating the stability of TiAlN layers when kappa alumina is gown upon them. TiAlN multilayer coatings were produced on standard WC/Co cemented carbide substrates, where kappa alumina layers were grown on top of TiAlN layers with different texture. The coatings were characterized by X-ray diffraction, scanning and transmission electron microscopy, and energy dispersive X-ray analysis. Focus were on how the microstructure of the different textured TiAlN layers changed when exposed to temperatures necessary for growing kappa alumina. The texture of the grown kappa alumina was also investigated. The results show that the TiAlN grains in both coatings keep their distinct lamellar nanostructure,[2] consisting of alternating Ti rich and Al rich lamellas, but that hexagonal AlN and cubic TiN can be found precipitated along grain boundaries in the TiAlN layers, see Fig 1. The orientation relationships between TiAlN and kappa alumina layers were also found.

References:

1. I. Endler et al: *Novel aluminum-rich $Ti_{1-x}Al_xN$ coatings by LPCVD*, Surface & Coatings Technology 203 2008 pp. 530−533

2. J. Todt et al: *Al-rich cubic Al0.8Ti0.2N coating with self-organized nano-lamellar microstructure: Thermal and mechanical properties*, Surface & Coatings Technology 291 2016 pp. 89 - 93

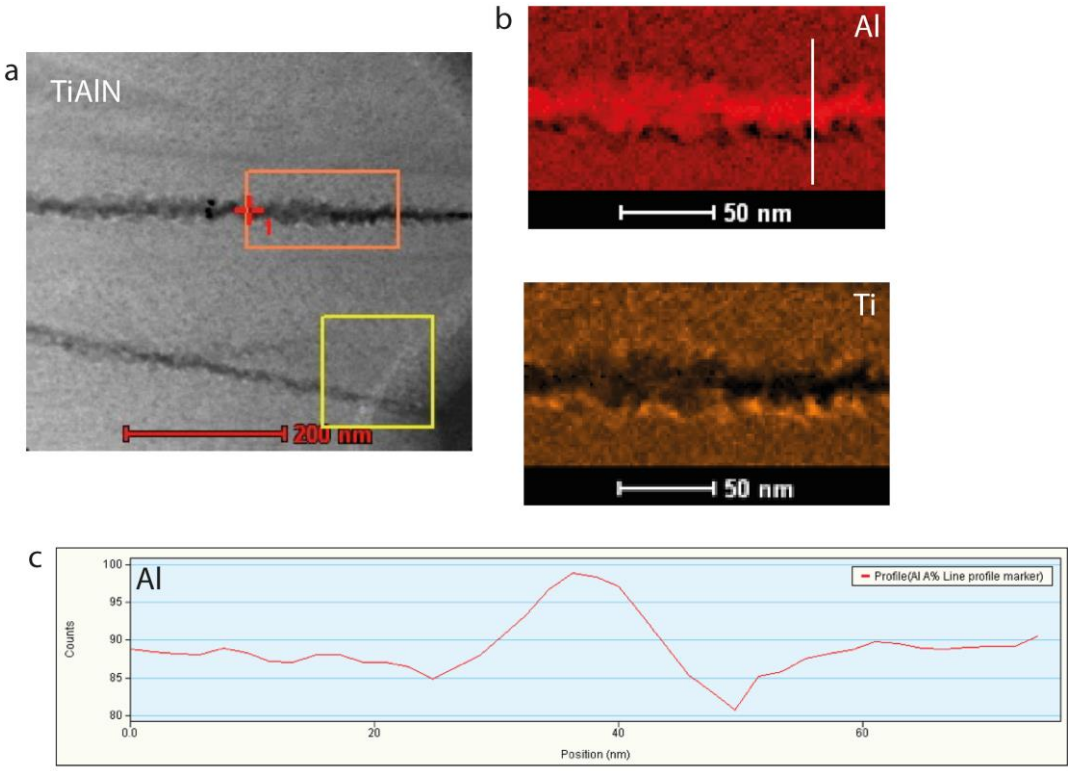

Figure 1. (a) HAADF STEM image of TiAlN grain bounday and surronding TiAlN grains. (b) Ti and Al EDX maps of TiAlN grain boundary seen in (a). (c) Line profile, top - bottom, showing the variation of Al over TiAlN grain boundary.