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Improved thermal stability in oxidation resistant AlCrN coatings through Ti alloying

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Thermal stability of protective tool coatings is an important factor for high speed and dry cutting during which the temperature can exceed 1000 °C. The abrasive wear resistance and the hardness of CrAlN coatings at elevated temperatures are low in comparison to other transition metal nitrides, for example TiAlN. In this study we report improved thermal stability of oxidation resistant CrAlN coatings through Ti alloying. Stoichiometric quaternary cubic (*c*)-$(Ti_xCr_yAl_{0.60})_1N_1$ coatings with different x to y ratios have been grown using reactive cathodic arc evaporation. When choosing x=~0.1 the mechanical properties at elevated temperatures are drastically improved compared to ternary CrAlN. The coatings show an age hardening process with retained hardness up to 1100 ºC. The oxidation resistance of the coatings is negatively affected by the Ti addition but they outperform ternary TiAlN. The observed hardness increase upon annealing is caused by AlN- and TiCrN-precipitation occurring within a TiAlCrN tissue phase. The precipitation is preferentially taking place in the vicinity of the grain boundaries along the growth direction. The addition of Ti delays the precipitation of AlN and consequently the coarsening process and the transformation of *c*-AlN into hexagonal (*h*)-AlN are also delayed. Furthermore, the detrimental effects of the hexagonal AlN phase are suppressed due to presence of Ti atoms within the *h*-AlN domains which impose lattice defects. It is concluded that quaternary TiCrAlN coatings can be synthesized to have both excellent mechanical properties and oxidation resistance.

Keywords
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