SUMMARY OF Ph.D. DISSERTATION

School Fundamental Science and Technology	Student Identification Number	SURNAME, First name Hasegawa Hiroyuki

Title

Synthesis and micro structural controls of ceramics nitride films.

Abstract

Metastable PVD films have been developed by incorporating second metals to binary nitride films in aims of gaining excellent mechanical and tribological properties. The cathodic arc method is a specialized method in creating metastable ternary films which cannot be synthesized under stable thermodynamic conditions. In this study, the maximum hardness of ceramics nitride films was discussed based on the phase transition analyzed by X-ray diffraction and scanning and transmission electron microscopy.

Ternary nitride films had higher microhardness than the binaries and had their own maximum hardness at certain values. Further, the addition of Al into TiN and CrN changed the crystal structures of both $Ti_{1-X}Al_XN$ and $Cr_{1-X}Al_XN$ films from the NaCl-type to Wurtzite-type at the X=0.6, while the structures of $Ti_{1-X}Cr_XN$ and $Ti_{1-X}Zr_XN$ retained the NaCl-type for all X values. The maximum microhardness of $Cr_{1-X}Al_XN$ and $Zr_{1-X}Al_XN$ was gained at phase transition point, where films had had some special microstructure with the mixture with crystal and amorphous.

Addition of Cr atoms to (Ti,Al) N films expanded maximum Al solubility up to 73 at.% without hexagonal phase segregation. The ***c***-$Ti_xCr_yAl_zN$ films obtained by thermal annealing were investigated with respect to phase transition, lattice parameter and microhardness. They were kept cubic type even up to 800 ºC. The lattice parameter of films at decreased by 0.5% compared with to that of room temperature. Finally, cubic phase was partially transformed into hexagonal phase through the thermal diffusion process over 900 ºC, which decreased its microhardness.

$Cr_XAl_YB_ZN$ films were synthesized by the cahodic arc method using Cr-Al-B alloy targets with differing Z values from 0 to 0.2 and investigated crystal structure and lattice parameter and micro-hardness. The microhardness of $Cr_XAl_YB_ZN$ films increased from 27(Z=0) to 33 GPa (Z=0.1) corresponding with decrease in lattice parameter.