CHAPTER V

CONCLUSIONS

Cr_xN thin films have been deposited on Si substrates by d.c. reactive magnetron sputtering from a Cr-metal target in a nitrogen and argon atmosphere. For this work, we investigated for the optimized condition of Cr_xN thin film and characterized the Cr_xN thin films.

First, the optimized condition for Cr_xN thin films was investigated by varying the partial pressure of nitrogen. The result from EDX shows that the composition of nitrogen in films increases as the nitrogen partial pressure increases. The optimized condition of the Cr_xN thin films was obtained with the nitrogen partial pressure between 40% and 60% for achieving the stoichiometric Cr_xN thin film. As we varied the growth temperature while the flow rate of Ar and N_2 was kept constant at the optimized condition. The Cr/N contents in the films are stoichiometry at all growth temperatures. This result confirms that the partial pressure in this process is appropriate to make the stoichiometric Cr_xN thin films. For XRD, CrN (111) dominates at all growth temperatures because it has lowest surface energy while CrN (200) starts to appear at 100 °C and tends to develop as the growth temperature increase. This is due to the development from the lowest surface energy to the higher surface energy. The FWHM of CrN (111) peak increases as the growth temperature increases doe to an increasing of the mosaicity structure and the competitive growth mode between CrN (111) and CrN (200) in the films. For the surface morphology, an increasing of the growth temperature causes the mobility of adatoms on the surface to increase. This leads to a smoother film at the higher temperature. However, Cr_xN thin films, which was grown at 100 °C has the highest roughness. This is due to the beginning of competition growth mode between CrN (200) and CrN (111).

For the preliminary hardness test, all Cr_xN thin films pass over the highest scale in both gouge hardness and scratch hardness as define in ASTM D3363-05. For nanoindentation hardness test, the hardness of Cr_xN thin films increases as the growth temperature increases. The film grown at 250 °C has the highest hardness at 15.74 GPa whereas it has the lowest wear rate value of 9.32×10^{-3} mm^3/ Nm. This result

shows the film grown at 250 °C has the highest properties in wear resistance that can be used to increasing the lifetime of tools.

For the low growth temperature of Cr_xN thin films, the external energy source such as ion – assisted can be used for the development of higher hardness. The growth direction can change from (111) to (200). The shift in the orientation can be occurred by high energetic ion bombardment. This will bring the system close to thermodynamic condition. These ions can transfer their energy by collisions without lattice rearrangement. (200) plane can develop for higher ion energy during the process [40]. The better quality of the film material can be achieved.