

REFERENCES

1. Chu, K., Shum, P.W. and Shen, Y.G., 2006, "Substrate Bias Effects on Mechanical and Tribological Properties of Substitutional Solid Solution (Ti, Al)N Films Prepared by Reactive Magnetron Sputtering", **Materials Science and Engineering B**, Vol. 131, pp.62-67.
2. Barshilia, H.C., Yogesh, K. and Rajam, K.S., 2009, "Deposition of TiAlN Coatings Using Reactive Bipolar-pulsed Direct Current Unbalanced Magnetron Sputtering", **Vacuum**, Vol. 83, pp.427-434.
3. Wrehde, S., Quaas, M., Bogdanowicz, R., Steffen, H., Wulff, H. and Hippler, R., 2008 "Optical and Chemical Characterization of Thin TiN_x Films Deposited by DC-magnetron sputtering", **Vacuum**, Vol. 82, pp.1115–1119.
4. Jeyachandran, Y.L., Narayandass, Sa.K., Mangalaraj, D., Areva, S. and Mielczarski, J.A., 2007 "Properties of Titanium Nitride Films Prepared by Direct Current Magnetron Sputtering", **Materials Science and Engineering A**, Vol. 445–446, pp.223–236.
5. Kelly, P.J., Vom Braucke, T., Liu, Z., Arnell, R.D. and Doyle E.D., 2007 "Pulsed DC Titanium Nitride Coatings for Improved Tribological Performance and Tool Life", **Surface & Coatings Technology**, Vol. 202, pp.774–780.
6. Shum, P.W., Tam, W.C., Li, K.Y., Zhou, Z.F. and Shen, Y.G., 2004, "Mechanical and Tribological Properties of Titanium-Aluminium-Nitride Films Deposited by Reactive Close-field Unbalance Magnetron Sputtering", **Wear**, Vol. 257, pp.1030-1040.
7. Singh, K., Limaye, P.K., Soni, N.L., Grover, A.K., Agrawal, R.G. and Suri, A.K. 2005, "Wear Studies of (Ti-Al)N Coatings Deposited by Reactive Magnetron Sputtering", **Wear**, Vol. 258, pp.1813-1824.
8. Shum, P.W., Li, K.Y. and Shen, Y.G., 2005, "Improvement of High-speed Turning Performance of Ti-Al-N Coatings by Using a Pretreatment of High-energy Ion Implantation", **Surface & Coatings Technology**, Vol. 198, pp.414-419.
9. Wuhrer, R. and Yeung, W.Y., 2004, "A Comparative Study of Magnetron Co-sputtered Nanocrystalline Titanium Aluminium and Chromium Aluminium Nitride Coatings", **Scripta Materialia**, Vol. 50, pp.1461-1466.

10. Chung, K.H., Liu, G.T., Duh, J.G. and Wang, J.H., 2004, "Biocompatibility of a Titanium–Aluminum Nitride Film Coating on a Dental Alloy", **Surface & Coatings Technology**, Vol. 188-189, pp.745-749.
11. Chen, J.T., Wang, J., Zhang, F., Zhang, G.A., Fan, X.Y., Wu, Z.G. and Yan, P.X. 2008, "Characterization and Temperature Controlling Property of TiAlN Coatings Deposited by Reactive Magnetron Co-sputtering", **Journal of Alloys and Compounds**, Vol. 472, pp. 91–96.
12. Wang, Y., Tam, P.L. and Shen, Y.G., 2008, "Behavior of $Ti_{0.5}Al_{0.5}N$ Thin Film in Nanoscale Deformation with Different Loading Rates", **Thin Solid Films**, Vol. 516, pp.7641-7647.
13. Liu, G.T., Duh, J.G., Chung, K.H. and Wang, J.H., 2005, "Mechanical Characteristics and Corrosion Behavior of (Ti,Al)N Coatings on Dental Alloys", **Surface & Coatings Technology**, Vol. 200, pp.2100-2105.
14. Oliveira, J.C., Manaia, A., Dias, J.P., Cavaleiro, A., Teer, D. and Taylor, S., 2006, "The Structure and Hardness of Magnetron Sputtered Ti-Al-N Thin Films with Low N Contents (<42 at.%)", **Surface & Coatings Technology**, Vol. 200, pp.6583-6587.
15. Manaila, R., Devenyi, A., Biro, D., David, D., Barna, P.B. and Kovacs, A., 2002 "Multilayer TiAlN Coatings with Composition Gradient", **Surface & Coatings Technology**, Vol. 151 –152, pp.21–25.
16. Shum, P.W., Li, K.Y., Zhou, Z.F. and Shen, Y.G., 2004, "Structural and Mechanical Properties of Titanium–aluminium–nitride Films Deposited by Reactive Close-field Unbalanced Magnetron Sputtering", **Surface and Coatings Technology**, Vol. 185, pp.245-253.
17. Wagner, J., Edlmayr, V., Penoy, M., Michotte, C., Mitterer, C. and Kathrein, M., 2008, "Deposition of Ti–Al–N Coatings by Thermal CVD", **International Journal of Refractory Metals & Hard Materials**, Vol. 26, 563–568.
18. PalDey, S. and Deevi, S.C., 2003, "Properties of Single Layer and Gradient (Ti,Al)N Coatings", **Materials Science and Engineering**, Vol. 361, pp.1-8.
19. Liu, Z.-J., Shum, P.W. and Shen, Y.G., 2006, "Surface Growth of (Ti,Al)N Thin Films on Smooth and Rough Substrates", **Thin Solid Films**, Vol. 496, pp.326-332.
20. Singh, K., Limaye, P.K., Soni, N.L., Grover, A.K., Agrawal, R.G. and Suri, A.K. 2005, "Wear Studies of (Ti–Al)N Coatings Deposited by Reactive Magnetron Sputtering", **Wear**, Vol. 258, pp.1813-1824.

21. Ramana, J.V, Kumar, s., David, C. and Saju, V.S. 2004, "Structure, Composition and Microhardness of (Ti,Zr)N and (Ti,Al)N Coatings Prepared by DC magnetron Sputtering", **Materials Letters**, Vol. 58, pp.2553-2558.
22. Cremer, R., Reichert, K. and Neuschütz, D. 2001, "A Composition Spread Approach to the Optimization of (Ti,Al)N Hard Coatings Deposited by DC and Bipolar Pulsed Magnetron Sputtering", **Surface & Coatings Technology**, Vol. 142-144, pp.642-648.
23. Oliveira J.C., Manaia, A. and Cavaleiro, A., 2008, "Hard Amorphous Ti-Al-N Coatings Deposited by Sputtering", **Thin Solid Films**, Vol. 516, pp.5032-5038.
24. Mei, F., Shao, N., Lun, W. and Li, G., 2005, "Effect of N₂ Partial Pressure on the Microstructure and Mechanical Properties of Reactively Sputtered (Ti,Al)N Coating", **Materials Letters**, Vol. 59, pp.2210-2213.
25. Musil, J. and Hruby, H., 2000, "Superhard Nanocomposite Ti_{1-x}Al_xN Films Prepared by Magnetron Sputtering", **Thin Solid Films**, Vol. 365, pp.104-109.
26. Lugscheider, B., Bobzin, K., Papenfug-Janzen, N., Maes, M. and Parkot, D., 2004, "Plasma Diagnostical Comparison of the MSIP Process of (Ti,Al)N with Pulsed and dc Power Supplies Using Energy-resolved Mass Spectroscopy", **Surface & Coatings Technology**, Vol. 188-189, pp.164-167.
27. Kutschej, K., Mayrhofer, P.H., Kathrein, M, Polcik, P., Tessadri, R. and Mitterer, C., 2005, "Structure, Mechanical and Tribological Properties of Sputtered Ti_{1-x}Al_xN Coatings with 0.5≤x≤0.75", **Surface & Coatings Technology**, Vol. 200, pp.2358-2365.
28. Barshilia, H.C., Prakash, K.M., Jain, A. and Rajam, K.S., 2005, "Structure, Hardness and Thermal Stability of TiAlN and Nanolayered TiAlN/CrN Multilayer Films", **Vacuum**, Vol. 77, pp.169-179.
29. B. Subramanian, K. Ashok, P. Kuppusami, C. Sanjeeviraja, M. Jayachandran, "Characterization of Reactive DC magnetron Sputtered TiAlN Thin Films", **Crystal Research and Technology**, Vol. 43 (2008) pp. 1078-1082.
30. Wuhrer, R. and Yeung, W.Y., 2002, "A Study on the Microstructure and Property Development of d.c. Magnetron Cospattered Ternary Titanium Aluminium Nitride CoatingsPart III Effect of Substrate Bias Voltage and Temperature", **Journal of Materials Science**, Vol. 37, pp.1993-2004.

31. Åstrand, M., Selinder, T.I. and Sjöstrand, M.E., 2005, "Deposition of $Ti_{1-x}Al_xN$ Using Bipolar Pulsed Dual Magnetron Sputtering", **Surface & Coatings Technology**, Vol. 200, pp.625-629.
32. Kim, G.S., Lee, S.Y. and Hahn, J.H., 2005, "Properties of TiAlN Coatings Synthesized by Closed-field Unbalanced Magnetron Sputtering", **Surface & Coatings Technology**, Vol. 193, pp.213-218.
33. Zhou, T., Nie, P., Cai, X. and Chu, P.K, 2009, "Influence of N_2 Partial Pressure on Mechanical Properties of $(Ti,Al)N$ Films Deposited by Reactive Magnetron Sputtering", **Vacuum**, Vol. 83, pp.1057-1059.
34. Liu, Z.-J., Shum, P.W. and Shen, Y.G., 2004, "Hardening Mechanisms of Nanocrystalline Ti-Al-N Solid Solution Films", **Thin Solid Films**, Vol. 468, pp. 161-166.
35. Wührer, R. and Yeung, W.Y., 2003, "Effect of Target-substrate Working Distance on Magnetron Sputter Deposition of Nanostructured Titanium Aluminium nitride Coatings", **Scripta Materialia**, Vol. 49, pp. 199-205.
36. Zhou, M., Makino, Y., Nose, M. and Nogi, K., 1999, "Phase Transition and Properties of Ti-Al-N Thin Films Prepared by R.F.-plasma Assisted Magnetron Sputtering", **Thin Solid Films**, Vol. 339, pp. 203-208.
37. Wikipedia, the free encyclopedia, **Solid solution** [Online], Available : http://en.wikipedia.org/wiki/Solid_solution [2010, December 3]
38. Zeng, X. T., Zhang, S. and Muramatsu, T., 2000, "Comparison of Three Advanced Hard Coatings for Stamping Applications", **Surface & Coating Technology**, Vol.127, pp. 38-42.
39. Surinpong, S., 2002. "PVD Surface Coating for Tooling", **Technique**, Vol. 198 pp. 122-125.
40. Knotek, O., Munz, W.D. and Leyendecker, T., 1987, "Industrial Deposition of Binary, Ternary, and Quaternary Nitrides of Titanium, Zirconium, and Aluminum", **Journal of Vacuum Science and Technology A**, Vol. 5 Issue (4) pp. 2173 - 2179.
41. Knotek, O., Böhmer, M., Leyendecker, T. and Jungblut, F., 1988, "The Structure and Composition of $Ti-Zr-N$, $Ti-Al-Zr-N$ and $Ti-Al-V-N$ Coatings", **Materials Science and Engineering A**, Vol. 105, pp.481-488.
42. **Coating Selection Guidelines** [Online], Available : http://www.northeastcoating.com/Coatings_1.htm [2010, December 3].

43. Tijnshoff, K. Mohlfeld, A., Leyendecker, T., FulS, H.G., Erkens, G., Wenke, R., Cselle, T. and Schwenck, M., 1997, "Wear Mechanisms of $(Ti_{1-x}Al_x)N$ Coatings in Dry Drilling", **Surface & Coating Technology**, Vol. 94-95, pp. 603-609.
44. Schuster, J.C. and Baure, J., 1984, "The Ternary System Titanium-Aluminum-Nitrogen", **Journal of Solid State Chemistry**, Vol. 53, pp. 260-265.
45. Chapman, B., 1980, **Glow Discharge Processes**, John Wiley & Sons, New York.
46. Wasa, K., Hayakawa, S., 1992, **Handbook of Sputter Deposition Technology**, Noyes Publications, Park Ridge, New Jersey.
47. Belkind, A., 2007, "How Plasmas are Made", **Vacuum Technology & Coating**, pp80-87. Noyes Publications, Park Ridge, New Jersey.
48. Mattox, D.M., 1998, "Handbook of Physical Vapor Deposition (PVD) Processing", Noyes Publications, Westwood, New Jersey.
49. Smith, D.L., 1995, **Thin-Film Deposition: Principle and Practice**, New York, McGraw-Hill.
50. Rivkerby, D.S. and Matthews, A., 1991, **Advanced Surface Coatings a Handbook of Surface Engineering**, Blackie and Son Limited, London.
51. Pokaipisit, A., 2007, **Study on the Deposition of Indium Tin Oxide Thin Films by Electron Beam Evaporation and Ion Assisted Deposition**, a Thesis Submitted in Partial Fulfillment of the Requirements for the Degree of Doctor of Philosophy (Physics), Faculty of Science, King Mongkut's University of Technology Thonburi.
52. The free encyclopedia, Wikipedia: **Atomic Force Microscope**, [Online], Available: http://en.wikipedia.org/wiki/Atomic_Force_Microscope, [2009, October 26].
53. Nanoscience Instruments, **Atomic Force Microscopy**, [Online], Available: [Http://www.nanoscience.com/education.html](http://www.nanoscience.com/education.html), [2009, October 26].
54. Jenkins, T.E., 1995, **Semiconductor Science, Growth and Characterization Techniques**, Prentice Hall International (UK) Limited, UK.
55. Chaiyakun, S., 2009, **Growth and Characterization of Nanostructure Anatase Phase TiO_2 Thin Films Prepared by DC Reactive Unbalanced Magnetron Sputtering**, a Thesis Submitted in Partial Fulfillment of the Requirements for the Degree of Doctor of Philosophy (Physics), Faculty of Science, King Mongkut's University of Technology Thonburi.

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INTERNATIONAL PUBLICATIONS

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2. Buranawong, A., Chaiyakhun, S. and Limsuwan, P., 2010. "Characterization of Aluminium Titanium Nitride Thin Films Deposited by Reactive Magnetron Co-sputtering". **Advanced Materials Research**, Vol.93-94, pp 340-343.
3. Chaiyakun, S., Buranawong, A., Deelert, T. and Witit-anun, N., 2008, "The Influence of Total and Oxygen Partial Pressures on Structure and Hydrophilic Property of TiO_2 Thin Films Deposited by Reactive DC Magnetron Sputtering", **Advanced Materials Research**, Vol.55-57, pp 465-468.

INTERNATIONAL CONFERENCES

1. Buranawong, A., Witit-anun, N., Chaiyakun, S. and Limsuwan, P., 2011. "The Crystal Structure, Surface morphology and Microstructure of Aluminium titanium nitride Thin Film Deposited by Reactive Unbalanced Magnetron Co-Sputtering at Room Temperature". In **The Pure and Applied Chemistry**

International Conference (PACCON), Miracle Grand Hotel, Bangkok, Thailand, Jan 5-7, 2011.

2. Buranawong, A., Witit-anun, N., Chaiyakun, S. and Limsuwan, P., 2010. "The Effect of Titanium Current on Structure and Hardness of Aluminium Titanium Nitride Deposited by Reactive Unbalanced Magnetron Co-Sputtering". **In The 5th International Conference on Technological Advances of Thin Films & Surface Coatings (ThinFilms2010) and The 1st international Conference on Advanced polymer and polymer composites (COMPO2010)**, Harbin Institute of technology, Harbin, People's Republic of China, July 11-14, 2010.
3. Buranawong, A., Witit-anun, N., Chaiyakun, S. and Limsuwan, P., 2009. "Characterization of Aluminium Titanium Nitride Thin Films Deposited by Reactive Magnetron Co-sputtering". **In International conference on Functionalized and Sensing Materials**, Chulabhorn Convention Center, Bangkok, Thailand, December 7-9, 2009.
4. Chaiyakun, S., Buranawong, A., Deelert, T. and Witit-anun, N., 2008, "The Influence of Total and Oxygen Partial Pressures on Structure and Hydrophilic Property of TiO₂ Thin Films Deposited by Reactive DC Magnetron Sputtering", **In International Conference on Smart Materials Smart/Intelligent Materials and Nanotechnology and 2nd International Workshop on Functional Materials and Nanomaterials**, Imperial Mae Ping Hotel, Chiang Mai, Thailand, April 22-25, 2008.
5. Witit-anun, N., Buranawong, A., Deelert, T. and Chaiyakun, S., 2007, "Structure and Hydrophilic Properties of Titanium Dioxide Thin Films Deposited by Reactive DC Magnetron Sputtering" **In German-Thai Symposium on Nanoscience and Nanotechnology**, The Tide Resort, Bangsaen Beach, Chonburi, Thailand. September 27-28, 2007.
6. Buranawong, A., Witit-anun, N., Deelert, T. and Chaiyakun, S., 2007, "Effect of Annealing Temperature on Hydrophilic Properties of Titanium Dioxide Thin Films Deposited by Reactive DC Magnetron Sputtering", **In German-Thai Symposium on Nanoscience and Nanotechnology**, The Tide Resort, Bangsaen Beach, Chonburi, Thailand. September 27-28, 2007.

NATIONAL CONFERENCES

1. Buranawong, A., Chaiyakun. S. and Limsuwan, P., 2010. "The Effect of Thickness on Structure of Aluminium Titanium Nitride Deposited by Reactive Magnetron Co-sputtering". **In Siam Physics Congress 2010**.
2. Buranawong, A., Witit-anun, N., Chaiyakun, S. and Limsuwan, P., 2009. "The Crystal Structure of Titanium Aluminium Nitride Thin Films Deposited by Reactive Co-Unbalance Magnetron Sputtering". **In 35th Congress on Science and Technology of Thailand 2009**.

3. Buranawong, A., Witit-anun, N. and Chaiyakun, S., 2008. "The Effect of O₂ Partial Pressure on Structure and Hydrophilic Property of TiO₂ Films Deposited by Reactive DC Unbalance Magnetron Sputtering". **In 9th National Grad research Conference 2008.**
4. Buranawong, A., Witit-anun, N., Thawornthira, C., Jongjitta, S., Deelert, T. and Chaiyakun, S., 2007. Effect of Oxygen Partial Pressure on Hydrophilic Properties of Titanium Dioxide Thin Films Deposited by Reactive DC Magnetron Sputtering. **In Siam Physics Congress 2007.**
5. Deelert, T., Witit-anun, N., Thawornthira, C., Jongjitta, S., Buranawong, A. and Chaiyakun, S., 2007. Determination of The Optical Constant of Titanium Dioxide Thin Films from Transmission Spectra. **In Siam Physics Congress 2007.**



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