

SUPERHAD COATINGS

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a continuing desire to develop improved coatings to obtain better yet performance for a wide range of applications.

REFERENCES

1. R.F. Bonshah (Editor), *Handbook of Hard Coatings*, Hayes Publications, Park Ridge, IL, 2001, Chapters 7-10.
2. S. Veprek, "The search for novel, superhard materials," *J. Vac. Sci. Technol.*, Vol. A 17, p. 2401, 1999.
3. A. Leyland and A. Matthews, "Development of ultra-thin, nano-structured and ultra-smooth coatings," *Surf. Coat. Technol.*, Vol. 177-178, p. 217, 2004.
4. M. Zemanek and A. Raneh, *Surf. Coat. Technol.*, The Int. Conf. on Superhard Coatings, Hobart, WA, Australia, 27-28 March, 1, 2007, *Surf. Coat. Technol.*, Vol. 200, No. 11, 2007.
5. Y.W. Chung and W.D. Sproul, "Superhard Coatings: Materials," *MRS Bull.*, Vol. 28, No. 3, p. 164, 2003.
6. D. Mattox, *Thin Films*, in *Handbook of Deposition for Films and Coatings*, 2nd ed., R.F. Bonshah (Editor), Chapter 6, Hayes Publications, Park Ridge, 1999, pp. 220-272.
7. D.M. Mattox, *Handbook of Physical Vapor Deposition (PVD) Processes*, Hayes Publications, Westwood, NJ, 1988.
8. D.W. Johnson and S.H. Coover, "Modification of evaporated chromium by co-evaporation of boron," *J. Vac. Sci. Technol.*, Vol. 17, p. 426, 1980.
9. J.C. Sandberg, "Structure and properties of TiN coatings," *Thin Solid Films*, Vol. 120, p. 21, 1985.
10. J. Gruber, *VN-Zinnanrichung*, R.L. Kosman, J. Goldmann, and R.Z. Witek, "Microstructure of Ti-N and Ti-B-N coatings deposited by vacuum arc," *Surf. Coat. Technol.*, Vol. 106, p. 159, 1998.
11. R.L. Kosman, V.N. Zhornitsky, J. Gruber, J. Rogopet, J. Goldmann and R.Z. Witek, "Structure and properties of vacuum arc deposited multicomponent nitride coatings of Ti, Zr and Nb," *Surf. Coat. Technol.*, Vol. 124, p. 287, 2000.
12. V.N. Zhornitsky, "Structure and properties of cathodic vacuum arc deposited TiN and Ti-B based multi-component and multi-layer coatings," *Surf. Coat. Technol.*, Vol. 201, p. 61-62, 2007.
13. H. Hähnel, "Material selection for hard coatings," *J. Vac. Sci. Technol.*, Vol. A 4, p. 2661, 1986.
14. S. Veprek, H.G.J. Veprek-Heijman, P. Baranovska and J. Prochazka, "Different approaches to superhard coatings and nanocomposites: Review," *Thin Solid Films*, Vol. 476, p. 1, 2006.
15. R.F. Zhang and S. Veprek, "On the spatial nature of the phase segregation and formation of stable nanocomposites in Ti-B-N system," *Metall. Sci. Eng.*, Vol. A 424, p. 130, 2006.
16. X. Chu, M.S. Wong, W.D. Sproul, S.L. Rohde, and S.A. Barnett, "The synthesis and properties of polycrystalline TiB₂/TiN superhard coatings," *J. Vac. Sci. Technol.*, Vol. 18, p. 1004, 1982.
17. X. Chu, S.A. Barnett, M.S. Wong, and W.D. Sproul, "Intrinsic ultra-low magnesian spicular deposition of polycrystalline TiB₂/TiN superhard coatings," *Surf. Coat. Technol.*, Vol. 57, p. 11, 1992.
18. W.D. Sproul, "Reactive sputter deposition of polycrystalline nitride and oxide superhard coatings," *Surf. Coat. Technol.*, Vol. 06-07, p. 33, 1996.
19. H. Hähnel and V. Scheer, "Multi-layer PVD coatings for wear protection," *Surf. Coat. Technol.*, Vol. 76-77, p. 23, 1995.
20. S. Hu, C. Dehler, S. Veprek and C. Zangl, "Superhard nitride-based nanocomposites: role of interface and field of impact," *Phys. Scr.*, Vol. 497, 080103, 2005.
21. S. Veprek, D. M. Fain, A. S. Agon and S. Veprek, "Stratum to Non-linear Rate-Independent Constitutive Modeling of Mechanical Properties of Hard and Superhard Materials: Instability Indicators," *Metall. Sci. Eng.*, Vol. A 480, p. 366, 2007.
22. A. Raneh, J. Zemanek, R. Shew, R. Axel, L. Lind, "Thermal stability of nanostructured coatings: A Review," *Surf. Coat. Technol.*, Vol. 201, p. 6136, 2007.
23. J. Zemanek, A. Raneh, R. Axel, L. Lind, "Thermal stability of superhard coating," *Surf. Coat. Technol.*, Vol. 201, p. 6140, 2007.
24. H. Hähnel and H. Stobber, "Thermal stability of Ti-B-N coating," *Surf. Coat. Technol.*, Vol. 201, p. 6140, 2007.
25. A. Cavallero and C. Loan, "Thermal stability of hard nanocomposite coatings with the W-C-H system in oxidant and positive atmosphere," *Surf. Coat. Technol.*, Vol. 201, p. 6154, 2007.
26. W. Han and E. Briscoe, "The influence of a heat treatment on the microstructure and mechanical properties of spined coatings," *Surf. Coat. Technol.*, Vol. 97, p. 325, 1997.
27. H. D. Hähnel, D.S. Paul, G. Mito, H. Hähnel and S. Veprek, "Thermal stability of superhard nanocomposite coating consisting of nanoscale inclusions," *Surf. Coat. Technol.*, Vol. 186-187, p. 20, 2004.
28. J. Zemanek, H. C. Würling, C. Egg and S. Veprek, "Thermal stability of Ti-B-N and C-B-N superhard nanocomposite coatings," *Surf. Coat. Technol.*, Vol. 146-147, p. 290, 2001.
29. S. Veprek and S. Bagricic, "A concept for the design of novel superhard coatings," *Thin Solid Films*, Vol. 303, p. 64, 1999.

30. A. Hähnel, H. Stobber, F. Hähnel, E. Mito, Ch. Egg, D.S. Paul and S. Veprek, "The role of porosity threshold for the control of the hardness and thermal stability of super- and ultra-hard nanocomposites," *Surf. Coat. Technol.*, Vol. 146-147, p. 120, 2001.
31. S. Veprek, H. Hähnel, S. Bagricic, L. Lind and J. Zemanek, "Novel thermodynamically stable and oxidation resistant superhard coating materials," *Surf. Coat. Technol.*, Vol. 86-87, p. 291, 1996.
32. J. Hähnel, S. Bagricic, J. Vybíral and S. Veprek, "The role of the magnesian spicular deposition of Ti-B-N," *Thin Solid Films*, Vol. 167, p. 107, 1989.
33. J. Zemanek, R. Grottel, H. Hähnel, C. Würling and J. Hähnel, "Structure and properties of hard and superhard Ti-Cu-B-N nanocomposite coatings," *Metall. Sci. Eng.*, A 200, p. 189, 2000.
34. S. Barnea and A. Hähnel, "Superhard nanoparticles," *Phys. Mater.*, Vol. 11, p. 45, 1998.
35. S.A. Barnett, A. Hähnel, L. Lind and J. Mattox, "Stability of nanoscale-thick layers in hard coatings," *MRS Bull.*, Vol. 28, p. 169, 2003.
36. H. Hähnel, E. Mito, J. Hähnel and C. Würling, "A comparative study on reactive and non-reactive sputtered nanocomposite superhard TiN coatings," *Thin Solid Films*, Vol. 415, p. 151, 2002.
37. J. Zemanek, A. Raneh, Y. Skovce, E. Shew, J.E. Hertzberg-Sophistic, and L. Mattox, "Thermal stability of TiN-BN high-temperature," *Surf. Coat. Technol.*, Vol. 201, p. 6161, 2007.
38. H. Hähnel, T. Czele, F. Hähnel, H. Hähnel, H. G. J. Veprek-Heijman and S. Veprek, "Development of novel coating technology by vacuum arc with reacting cathodes for industrial production of the TiN-TiB₂-Si₃N₄ superhard nanocomposite coatings for dry hard machining," *Proc. Conf. Plasma Process.*, Vol. 24, p. 469, 2004.
39. T. Czele, in *Superhard Technology*, A. Zemanek, ed. E. Weimer, Walter Verlag, Essen, 2005, p. 209.

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SVC FOUNDATION NEWS

John B. Penn, Jr., Foundation Board member, reported at the 2007 SVC TechCon Annual Business Meeting that the Foundation under the leadership of the new Board of Directors, has reached a critical mass by developing a mission that can resonate with the membership of the SVC and beyond, as demonstrated by one way the Foundation is beginning to be used by its constituency. To date, more than \$200,000 has been donated, with more than 442,000 in scholarships awarded to date. Cash donations and matching funds from the SVC (\$87,000 to date) are significant, but it is important to note that well over half of the donations are from individual members. Following are some recent examples:

Bernard Henry, loved and respected by many in SVC and AIMCAL, passed away this year. In cooperation with both the SVC and AIMCAL, the SVC Foundation has established a special scholarship fund in his name that will allow individual designated contributions to be pooled in the form of creating an endowed, perpetual Bernard Henry scholarship (if the amount raised exceeds \$90,000), or one or more Bernard Henry scholarships if the amount raised is less. We encourage the friends of Bernard Henry, whether based in the SVC, or AIMCAL, to make a donation in his memory toward the goal of creating a perpetual, endowed scholarship in his name. See page 54 in this Bulletin for a tribute from SVC to Bernard Henry.

Michael Hester was a Past President of the SVC who passed away several years ago. It was important to Jim Sasser in several ways, not only for his good nature and positive attitude, but also for introducing him to many aspects of the vacuum coating business and participating, in 1977, to the SVC and the benefit of membership. Michael became active in the SVC, being President 1980-1982 and thus also had an important impact on many others. A donation to the Foundation in Michael's name was the perfect way for Jim to remember him and to remind others of his contributions. We remember him fondly.

Don Mattox has donated his 2007 Nathaniel Stogomemorial Award check to the Foundation. Don was an early supporter of the Foundation, and this gift shows his continued support and commitment to its cause. We appreciate both the symbolism and the substance of the gift.

The 2007 SVC Penn Run and Walk, organized by Wolfgang Docker, had a total of 25 sponsors, 68 runners and walkers (at 6 am, no less), and raised a total of \$9,200. Only in its second year, this continues to be a great success story. See page 40 for more details.



Michael Hester

SVC Foundation Scholarships

In 2007 the Foundation awarded three scholarships as follows:
 SVC Foundation Scholarship: Nicholas Vectors, undergraduate student, California Polytechnic State University

The Jane and Frank Warchol Scholarship: Manuel J. Godoy, undergraduate student, California Institute of Technology
 The Fern Scholarship: Marjorie Auftrunk, graduate student, University of Shelbyville, UK

A total of 11 scholarships have been awarded since the founding of the SVC Foundation in 2002. Nicholas Vectors seeks to let us know that our scholarship would allow him to complete his research. Following

the desire of Jane and Frank Warchol to do more with their donation as soon as possible, more scholarships will be awarded next year. Frank Warchol, founder of VacoCoat Technologies, Inc., is now an active philanthropist and his address to us is very helpful.

The Scholarship Committee works very hard to solicit, screen, and award scholarships. Last year's committee was Paolo Raugei, chair, with members Hans Baranovska, and John B. Penn, Jr. Several people have expressed interest in joining the committee next year. If you are interested, please contact Paolo at praugei@vaco.com.

SVC Foundation Booth at the 2007 TechCon

Through a generous donation from SVC, the SVC Foundation had a booth this year at the 2007 Annual TechCon in Louisville, KY. The booth staff presented all of our current donors as well as the scholarship recipients through 2007. The booth also provided a valuable meeting spot to talk with new potential donors. Additionally, we used the booth to register runners for the 5K Penn Run and Walk.

In addition to financial support, we also solicited (and received) individuals who will serve on various committees (for example the Scholarship Review Committee). Thanks to all of you who visited the booth and to all of our current donors and volunteers. We will have a booth again next year, so those who missed us this year, please stop by and see how you can contribute to the Foundation Mission.

As a volunteer organization, we always need help at the board level or the committee level to organize the GK team and the Scholarship Committee. In particular we need help from individuals who can help us build up a better Foundation Web Site. 2007 is becoming a great year for us, and we hope that either by your donations or by your contribution time, you can help 2008 to be an even greater year. Contact any board member or Jim Sasser at jssasser@vaco.com.

Thanks to all of you for your support. In particular, I want to thank William Mattox and the SVC Board for their valuable behind the scenes support (the page, booth space, administrative support, etc.) that help make it possible for us to function effectively.



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