VIDEO ARTICLE

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Microwave Plasma Chemical Vapor Deposition of Diamond and Novel Superhard Materials

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Abstract

This talk will cover microwave plasma chemical vapor deposition of diamond and novel superhard modifications based on Boron-Carbon-Nitrogen (B-C-N) material systems. The control of gas phase chemistry in the microwave plasma chemical vapor process has resulted in the high-growth rate homoepitaxial diamond process for gem-diamond fabrication and for the fabrication of diamond-based sensors utilized in the study of materials under extreme conditions. The gas phase chemistry has been also developed for the synthesis of nanocrystalline diamond coatings on metals and alloys for biomedical implant applications. In recent-years, the focus has shifted on novel superhard B-C-N) material systems which have higher thermal stability than diamond and can operate at higher temperatures. Microwave plasma chemical vapor deposition process has been successful in the large-area synthesis of materials like $B_{50}C_2$ and amorphous B-C-N materials with hardness greater than 40 GPa. I will also discuss recent Machine Learning (ML) approaches used in prediction of novel B-C-N materials and how these ML predictions are going to guide the future landscape of plasma synthesis of superhard materials.

Biography of Presenting Author

A. PROFESSIONAL PREPARATION

INSTITUTION	LOCATION	MAJOR/AREA OF STUDY	DEGREE (if applicable)	YEAR (YYYY)
Delhi University	Delhi, India	Physics	B.S.	1972
Delhi University	Delhi, India	Physics	M.S.	1974
Bombay University	Bombay, India	Physics	Ph.D.	1980
University of Paderborn	Paderborn, Germany	Physics	Postdoctoral	1981-1982
Cornell University	Ithaca, New York	Materials Science and Engineering	Postdoctoral	1984-1988

B. APPOINTMENTS

From - To	Position, Title, Organization and Location
2014-	Member Councilor, Oak Ridge Associated Universities (ORAU), Oak Ridge, TN
2011-	Associate Dean, College of Arts and Sciences, UAB, Birmingham, AL
2006-	Director, Center for Nanoscale Materials and Biointegration, UAB, Birmingham, AL
2001-	Professor and University Scholar, UAB, Birmingham, AL
1998-	Professor, Department of Materials Science and Engineering, UAB, Birmingham, AL
1997-	Campus Director - NASA Alabama Space Grant Program, UAB, Birmingham, AL
1997-2012	Director, Graduate Program in Physics, UAB, Birmingham, AL
1996-	Professor, Department of Physics, UAB, Birmingham, AL
1992-1996	Associate Professor, Department of Physics, UAB, Birmingham, AL
1988-1992	Research Assistant Professor, Department of Materials Science and Engineering, Cornell University, Ithaca, NY

Other Experience and Professional Memberships

Life member	American Physical Society (APS)
2005-	Served on Nanotechnology, Biomaterials, and Tissue Engineering study sections for the National Institutes of Health (NIH)
2005-	Served on various review panels for the Division of Materials Research at NSF
2004-2010	Editorial Board, Current Nanoscience (CNANO)
2002-2010	Editorial Board, Journal of Nanoscience and Nanotechnology (JNN)
2002-	Editorial Board, High Pressure Research
1999-	Member, Materials Research Society (MRS)
1999-	Campus Director, NASA-Alabama Space Grant Consortium
1997-2012	Director, Graduate Program in Physics
1997-	Director, NSF, Research Experiences for Undergraduates (REU)-Site

Honors

2016	Sam Brown Bridge Builder Award
2003	Caroline P. and Charles W. Ireland Prize for Scholarly Distinction, UAB
2001-	Chartered Physicist and Fellow of the Institute of Physics, United Kingdom
2000-2002	National Science Foundation (NSF) - Research Creativity Award
1981-1982	Alexander Von Humboldt Fellowship for Post-doctoral Research, Germany

Broad Research Interests:

- High pressure research on materials
- Synthetic diamond crystals and thin films
- Nanostructured materials for biomedical implants and devices
- Nanoindentation and mechanical wear behavior of materials
- Phase transformations in metals, alloys, and ceramic materials
- Microwave and laser plasma deposition of materials

Recent Scholarly and Educational Achievements:

- 25 PhD students and 10 MS students have completed their dissertation research under my direct supervision during 1992-2020.
- 366 research papers in peer reviewed international journals and conference proceedings.
- PI or Co-PI on research grants from NSF, NIH, DOE, NASA, DoEd, and industry.
- 5 patents awarded and one pending on synthetic diamond technology.
- Research creativity award by the National Science Foundation in 2000.
- NSF and NASA undergraduate and graduate educational programs on UAB campus.

US and International Patents Awarded in Materials Science and Technology:

(1) United States Patent Number 5,628,824 entitled "High Growth Rate Homoepitaxial Diamond Film Deposition at High Temperatures by Microwave Plasma-Assisted Chemical Vapor Deposition, Yogesh. K. Vohra and Thomas. S. McCauley, Date of Patent: May 13, 1997.

(2) United States Patent Number 6,183,818 entitled "Process for Ultra Smooth Diamond Coating on Metals and Uses Thereof", Yogesh K. Vohra and Shane A. Catledge, Date of Patent: February 6, 2001.

(3) United States Patent Number 6,858,078 entitled "Apparatus and Method for Diamond Production", Russell J. Hemley, Ho-kwang Mao, Chih-Shiue Yan and Yogesh K. Vohra, Date of Patent: February 22, 2005.

(4) U.S. Provisional Patent Application No. 60/721,697 entitled "Ultra Smooth Nanostructured Diamond Films and Compositions and Methods for Producing same", by Valeriy V. Konovalov, Yogesh K. Vohra, and Shane A. Catledge, Filed on September 29th, 2006.

(5) United States Patent Number 7,235,130 entitled "Apparatus and Method for Diamond Production", Russell J. Hemley, Ho-kwang Mao, Chih-Shiue Yan and Yogesh K. Vohra, Date of Patent: June 26, 2007.

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