

The Department of Mechanical Engineering presents:

Dr. Randall M. German

Associate Dean of Engineering
Professor of Mechanical Engineering
San Diego State University

rgerman@mail.sdsu.edu

619-594-7006



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Bourns Hall A265

Powder Injection Molding of Titanium Medical Devices and Implants

Abstract: Powder injection molding exceeds at forming complicated shapes, typical to plastic molding, but from common metal or ceramic systems. The technology emerged for computer disk drive, firearm, cellular telephone, and automotive applications. Most recently the technology has made significant penetration into medical instrument and device fabrication. Accordingly, titanium is an important material for small, complicated implants and tools. An analysis has been conducted on titanium powder injection molding (titanium (Ti), titanium alloys (Ti-6Al-4V, Ti-6Al-7Nb), and titanium compounds (TiAl, NiTi)). This presentation will cover the progress in realizing this option with examples of the materials, properties, and applications ranging from early demonstrations in running shoe spikes to pending human implants. Each of the process factors is isolated to identify the best practices, especially with respect to alloy contamination. The presentation will cover the powder, polymeric binders, feedstock formulation, mixing route, molding practice, polymer removal from the molded object, sintering densification, and post-sintering effects. Mechanical properties are linked to factors such as the sintering time, sintering temperature, debinding cycle, initial powder packing density, and oxygen content. These results help optimize processing toward specific performance objectives. Example applications from toys (already realized) to heat valves (yet to be realized) will be shown.

Bio: Associate Dean of Engineering, Professor of Mechanical Engineering, San Diego State University (2008 on), 5500 Campanile Drive, San Diego, California 92182-1326. Rand obtained his PhD from the University of California at Davis (1975), following an MS degree in Metallurgical Engineering from The Ohio State University (1971) and an honor's BS degree in Materials Science and Engineering from San Jose State University (1968). He is honored as a distinguished alumnus from all three. He completed a management science program at the RPI's Hartford Graduate Center and an intensive academic management program at Harvard University.

He holds an honorary doctorate from the University Carlos III de Madrid. In addition, he is a Fellow of the American Society for Metals and Fellow of American Powder Metallurgy Institute. His awards include the Tesla Medal, Nanyang Professorship, Japan Institute for Materials Research Lectureship, Penn State Engineering Society Outstanding Research Award and Premiere Research Award, Distinguished Research Award from the Japan Society for Powder Metallurgy, University of California at Davis Distinguished Engineering Alumni Award, The Ohio State University Distinguished Engineering Alumnus Award, San Jose State University Award of Distinction, Technical Development Award from the Japan Institute of Metals, Honorary Member of Alpha Sigma Mu, Society of Automotive Engineers Teetor Award, Honorary Professorship at Northeast University of Technology, RPI Early Career Award, Geisler Young Metallurgist Award, Kuczynski Prize, and Samsonov Prize. He is listed in several *Who's Who* and serves as an editor, key reader, and reviewer for more than 20 journals. He has been involved in a dozen start-up companies, has held a variety of director positions, including two terms as Director of APMI, and served on the Fellows Awards Committee of two professional societies. He served the Honorary Degree Committee, Promotion and Tenure Committee, and headed 19 chaired professor searches. Rand is currently on the board of directors of International Nontoxic Composites and Allomet, and serves on the Technical Advisory Board for Pangaea Ventures, Funds I and II.

Professor German has supervised 100 theses, published over 900 articles and 25 patents, and authored 15 books, including *Mathematical Relations in Particulate Materials Processing* (2008), *Powder Metallurgy and Particulate Materials Processing* (2005), *Liquid Phase Sintering* (1985), *Sintering Theory and Practice* (1996), and *Powder Injection Molding - Design and Applications* (2003). He co-edited 19 books, holds 24 patents, and co-chaired more than 30 conferences.

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