Anand (Andy) R. Shah

MS, MBA, PE

Principal, Director Polymeric, Composite & Non-metallic Materials

As a Principal and a Director of the Polymeric, Composite & Non-metallic Materials practice, Mr. Shah oversees materials and analysis personnel and related work across offices of ESi.

Mr. Shah conducts and leads investigations on the performance of products made from plastics, composites, and elastomeric materials for use in diverse applications. He specializes in product failure analysis, material characterization testing, investigations on the appropriateness of the choice of materials for their intended application, evaluating the influence of processing parameters on product performance, and evaluating product design. He has published his work in numerous technical journals and is a co-author of the *Fractography in Failure Analysis of Polymers* book with a second edition released in 2024.

In his 29 years of experience, he has evaluated incidents related to product, systems, and component failures in plumbing, transportation, construction, electrical, oil and gas, chemical processing, medical, and consumer industry. His experience also includes investigating formulations of polymers in paints, coatings, adhesives, and lubricants.

He utilizes the study of interpretation of fracture surface features (fractography) and principles of structure property relationship in polymers to provide solutions to plastic product performance and service life issues. Mr. Shah has provided testimony in matters pending before both state and federal courts.

Education

BS, Biomedical Engineering. Case Western Reserve University. 1995

MS, Macromolecular Science. Case Western Reserve University. 1986

MBA, Business Administration. DeVry University. 2003

Licenses & Certifications

- State of Alabama P.E. License 38935-E
- State of Illinois P.E. License 062-058788

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Areas of Specialization

- Plastic Failure Analysis
- Environmental Stress Cracking in Plastics Consumer Products
- Material Selection Consulting
- Fatigue & Fracture Mechanics
- Product Design Evaluation
- Creep & Stress Rupture of Plastic
- Chemical Compatibility Testing
- Service Life Prediction
- Analytical Testing
- Non-Destructive Testing & Inspection
- Mechanical Testing

Positions Held

Engineering Systems Inc., Aurora, Illinois

- Principal, 2018 – Present
- Senior Managing Consultant, 2015–2018
- Senior Consultant, 2010–2015

Illinois Institute of Technology, Chicago, Illinois

- Adjunct Faculty, MMAE Department, 2014–2023

Packer Engineering, Inc., Naperville, Illinois

- Director, Materials Engineering, 2005–2010

Bodycote Polymer Broutman Lab, Melrose Park, Illinois

- Manager, Materials Testing, 2000–2005

Broutman and Associates, Chicago, Illinois

- Senior Research Engineer, 1997–2000

Professional Affiliations/Honors

Society of Plastics Engineers

- Member, 1999 – Present
- Chairman, FAPSIG Annual Technical Meeting, 2014–2015
- Technical Program Chair, FAPSIG Annual Technical Meeting, 2012–2013
- Moderator, ANTEC Failure Analysis & Prevention Sessions, 2000, 2009, 2010
- Peer Reviewer

American Society of Testing and Materials

- Member, 2015 – Present

Society for Biomaterials

- Member, 2015 – Present

Society for Advancement of Materials and Processing Engineering

- Member, 2015 – Present

Publications

“Polymers” a chapter in Atlas of Fractographs, C.J. Schroeder, R.J. Parrington, J.O. Maciejewski, J.F. Lane, ASM Handbook, Volume 12A, 2025. Contribution, **A.R. Shah,** M. Ebert, J. Sommer, and G. Nagalia, Engineering Systems Inc.: Created and captioned Figures 16-23, pages 420-422.

“A study of CPVC Fire Suppression Sprinkler Pipe Chemical Compatibility with common Plasticizers found in Wires and Cables” G. Nagalia, **A.R. Shah**, E.D. Bain Society of Plastics Engineers, ANTEC® 2025, Philadelphia, PA, Mar 2025.

“Fractography in Failure Analysis of Polymers: 2nd Edition,” **A.R. Shah**, D.B. Edwards and M.D. Hayes, Elsevier, ISBN 978-0-443-29149-4, 2024.

“Best Safety Practices for Stability of PVC Pipe Bundles During Transport,” **A.R. Shah**, D.B. Brickman, G. Rogers, L. Rewerts, and J. Petersen, Proceedings of the XXXV Annual International Occupational Ergonomics and Safety Conference, Munich, Germany, October 9–10, 2023.

“Fracture of Plastics,” **A.R. Shah** and D.B. Edwards, Characterization and Failure Analysis of Plastics, ASM Handbook, Vol. 11B, 2022.

“Service Lifetime Assessment of Polymeric Material Products,” **A.R. Shah** and D.B. Edwards, ASM Handbook, Vol. 11, 2020.

“Failure Analysis and Prevention,” **A.R. Shah** and D.B. Edwards, Fracture of Plastics, ASM Handbook, Vol. 11, 2019.

“Preventing Failures in Elastomeric Resistance Bands,” **A.R. Shah**, D.B. Brickman, J.F. Grzetic, and J.T. Eganhouse, Proceedings of the Society of Plastics Engineers Annual Technical Conference, pp. 1–11, 2017.

“Fractography in Failure Analysis of Polymers,” **A.R. Shah**, M.D. Hayes and D.B. Edwards, Elsevier, ISBN 978-0-323-24272-1, 2015.

“Rudin and Choi’s Elements of Polymer Science and Engineering: 3rd Edition,” A. Rudin and P. Choi, Technical Review, **A.R. Shah,** Elsevier, ISBN: 978-0-12- 382178-2, 2012.

“Determination of Environmental Stress Cracking Failure Mode in Investigation of CPVC Fire-Suppression Sprinkler Pipe Failures,” **A.R. Shah** and D.B. Edwards, Proceedings of the Society of Plastics Engineers Annual Technical Conference, 2012.

“Failure Analysis of Plastic Crimp Fitting Assemblies,” **A.R. Shah**, D.E. Duvall, and D.B. Edwards, Proceedings of the Society of Plastics Engineers Annual Technical Conference, pp. 1–5, 2011.

“Preventing Plastic-Product Failures,” **A.R. Shah**, Plastics Engineering, pp. 22–27, July 2010.

“Role of Finite Element Analysis: A Computer Aided Engineering Technique in Failure Analysis of Plastic Products,” **A.R. Shah**, K. Nakamoto, and B. Agarwal, Proceedings of the 12th Annual International Conference on Industrial Engineering Theory, Applications, and Practice, 2007.

“Prediction of Service Life in a Chemically Active Environment Using Stress Rupture Data,” **A.R. Shah**, P.K. So, and L.J. Broutman, Journal of Applied Medical Polymers, Vol. 4, No. 2, pp. 88–93, 2000.

"An Alternative Method for Determining the Hydrostatic Design Basis for Plastic Pipe Materials," **A.R. Shah**, L.J. Broutman, E.F. Palermo, and D.B. Edwards, Proceedings of the International Plastic Pipe Symposium, 1998.

"Stepwise Fatigue Crack Propagation in Polyethylene Resins of Different Molecular Structure," **A.R. Shah**, A. Hiltner, and E. Baer, Journal of Polymer Science: Part B: Polymer Physics, Vol. 36, pp. 2355–2369, 1998.

"Study of Polyethylene Pipe Resins by a Fatigue Test that Simulates Crack Propagation in Real Pipe," **A.R. Shah**, A. Hiltner, and E. Baer, Journal of Materials Science, April 1997.

"Strength of the PC-SAN Interface as Determined by Delamination of Polymer Microlayers," a chapter in Interfacial Aspects of Multicomponent Polymer Materials, Dr. A. Hiltner, T. Ebeling, Dr. E. Baer, **A.R. Shah**, C. Mueller, Elsevier, ISBN: 978-1-4757-5559-6, 1997.

"Correlation of Fatigue Crack Propagation in Polyethylene Pipe Specimens of Different Geometries," **A.R. Shah**, A. Hiltner, and E. Baer, International Journal of Fracture, September 1996.

Presentations

"Importance of Standard Test Methods in Investigations of FRP Composite Ladders," **A.R. Shah**, E.H. Knox, and P.D. Umberger, IMAT 2024, Cleveland, OH, October 2024.

"Best Safety Practices for Stability of PVC Pipe Bundles During Transport," **A.R. Shah**, D. Brickman, G. Rogers, L. Rewerts, and J. Petersen, XXXV Annual International Occupational Ergonomics and Safety Conference, Munich, Germany, October 9, 2023.

"Failure Analysis of TPU Gaskets Used in Hydraulic Fluid Systems," **A.R. Shah**, L.N. Meissner, J.R. Babcock, and G. Nagalia, IMAT 2023, Detroit, MI, October 2023.

"Failure of Plastic Components Caused by Response to COVID-19 Pandemic," **A.R. Shah**, E.D. Bain, and G. Nagalia, IMAT 2022, New Orleans, LA, September 2022.

"Failure Analysis of Products with Plastic to Metal Threaded Connections," **A.R. Shah** and D.B. Edwards, Society of Plastics Engineers, ANTEC® 2021, Virtual, 2021.

"Failure Analysis of Polymer Coating Systems," **A.R. Shah**, G. Nagalia, and D.B. Edwards, Society of Plastics Engineers, ANTEC® 2020, Virtual, 2020.

"Quantifying Oxidative Degradation in Polyolefin Pipe by IR Spectroscopy," **A.R. Shah** and D.E. Duvall, ANTEC Conference, Orlando, FL, 2018.

"Failure Analysis of Plastic Gas Piping," **A.R. Shah**, U.S. Department of Transportation, Transportation Safety Institute/PHMSA Seminars on Pipeline Failure Investigation Techniques, 2014–2016.

"Failure Analysis and Prevention," **A.R. Shah**, ESi Annual Seminar, Aurora, IL, 2015, 2018, 2023.

"Computed Tomography X-Ray Imaging: A Technique for Non-Destructive Examination of Plastic Products," **A.R. Shah**, J.G. Jordan, and A. Richards, Society of Plastics Engineers Annual Technical Conference, Orlando, FL, March 2015.

"Introduction to Fiber-Reinforced Plastic Composites," **A.R. Shah**, Adjunct Professor, Lewis University, Romeoville, IL, 2010–2013.

"A Discussion on Prevention of Plastic Product Failures," **A.R. Shah**, Society of Plastics Engineers Annual Technical Conference, Orlando, FL, May 2010.

"The Effect of Marking Paint on Walking Surface Slip Resistance," **A.R. Shah**, D.G. Curry, R. Reinke, and J. Kidd, International Conference on Slips, Trips and Falls 2007: From Research to Practice, Hopkinton, MA, August 2007.

"Characterization of Continuous Fiber Reinforced Chemically Bonded Ceramic Composites," **A.R. Shah**, M. Pareek, J. Rigsby, and B. Agarwahl, Materials Science & Technology 2006: Ceramic Matrix Composites, Cincinnati, OH, October 2006.

"Significance of Creep Rupture and Stress Relaxation Data in Product Design and Material Suitability Evaluation," **A.R. Shah**, Annual Technical Conference of Society of Plastics Engineers, Boston, MA, May 2005.

"Failure Analysis and Prevention," **A.R. Shah**, Instructor, Annual Seminar Course, Society of Plastics Engineers and Bodycote Materials Testing, 2000–2004.

"Mechanical Strength Properties of Silicone Gel Filled Breast Prosthesis After Explanation," **A.R. Shah**, Sixth World of Biomaterials Congress Meeting, Kamuela, HI, May 2000.

"Fatigue Acceleration of Slow Stepwise Crack Growth in Polyethylene Pipe Materials," **A.R. Shah**, A. Hiltner, E. Baer, International Symposium on Plastic Piping Systems for Gas Distribution, Santa Clara, CA, October 1997.

"Correlation of Fatigue Crack Propagation Between Compact Tension and Real-Pipe Geometry," **A.R. Shah**, A. Hiltner, and E. Baer, Society of Plastics Engineers Annual Technical Conference, Indianapolis, IN, May 1996.