RANDY LEE . . . . . Huntsville, AL . . . . . rel007@reagan.com

CAREER SUMMARY

Senior Materials Scientist, Research Chemist, Multi-Disciplined Engineer, Principal Investigator & R&D Manager with over 45 years of hands-on industry experience in leading edge technologies, experimental R&D, industrial processing, shop manufacturing, building/laboratory layout, design, and facility support during construction of R&D laboratories, pilot lines, prototype and processing facilities in the areas of Advanced Composites, Carbon-Carbon, Ceramics Matrix Composites, High Temperature Ablatives, Polymer Chemistry, Electrochemistry, Coatings Formulation and Surface Finishing of Various Substrates. Scaled-up new products and processes from laboratory R&D to pilot line mini-production.

SKILLS & EXPERIENCES

COMPOSITE MATERIALS SCIENCE

> Superior hands-on skills in the design, fabrication, analysis and repair of leading edge composite systems derived from fibers, fabrics and 3-D networks comprised of continuous tow and chopped reinforcements of carbonized rayon, PAN and pitch, E/S-glass, SiO_2, SiC, Nextel, PE, Kevlar and carbon/ceramic nanoparticles combined with thermoplastic/thermoset/elastomeric matrices of polyester, epoxy, urethane, vinyl ester, NBR, urethane/acrylate and in particular, high glass transition phenolics, polyimides, cyanate esters, pitch, silicones, preceramic silanes, siloxanes, and polymer/fiber-modified concrete. Adept at the formulation, manufacture and failure analysis of novel composites for high performance applications with numerous innovations in Carbon-Carbon (C-C) composites, Polymer Matrix Composites (PMC), Ceramic Matrix Composites (CMC) and all their components and constituents. Hands-on involvement in wet lay-up, composite fab, adhesive bonding and coatings since age 13 (family business).

POLYMER, ORGANIC AND INORGANIC CHEMISTRY

> Exclusive hands-on skills in the formulation, R&D, processing and characterization of resins, coatings, adhesives, sealants, binders, plastics, lubricants, cleaners, degreasers, textiles, encapsulants, sol gels, anti-corrosion barriers, high temperature plastics, ablatives, ceramic precursors, and advanced composite matrices utilizing oligomers, prepolymers, dendrimers, dispersions, emulsions, surfactants, particles, thermoplastics, semi-crosslinked elastomers and high crosslink thermosetting heteropolymer networks. Unique talents for organic reaction mechanisms, strategic synthetic pathways, novel macromolecular design, functional group chemistry, surfactant technology, chemical coupling, crosslinked networks, glass transition temperature modification and polymer thermal decomposition kinetics. Adept in the theory, industrial processing, molding, curing, fabrication and characterization of state-of-the-art amorphous/semi-crystalline graft co-polymers, block elastomers, surface active polymers, mesogenic (liquid crystal) polymers, inorganic hybrid polymers, organometallic polymers and smart polymers.

CERAMICS & CARBON MATERIALS SCIENCE

> Strong expertise and hands-on skills in the formulation, fabrication and characterization of: (a) polycrystalline monoliths and glassy ceramics based on the oxides, carbides, silicides, nitrides and cermets of Si, Al, Zr, Ti, B and Mg, particularly SiC, Si_3N_4, SiO_xC_y, SiO_xN_y, SiO_2, Al_2O_3 and mixtures thereof; (b) polymer-derived ceramics for coatings, adhesives, densification impregnants and composite fabrication; (c) functionally graded ceramicized conversion bilayers for oxidation protection via pack mix cementation, CVD/CVI, CVC and sol gel processing, (d) anisotropic porous graphite and synthetic (pseudo-isotropic) 3-D graphite (> 4000°F), coal tar and pitch mesophase carbons, amorphous carbons, glassy carbon, 2-D graphene and pyrolytic CVD carbon. Exclusive skills in pyrolysis/combustion chemistry, thermal conversion and decomposition kinetics, differential thermal expansion (CTE) and thermal shock mitigation, control of permeability, closed porosity and interconnected pore networks.

MANUFACTURING PROCESS DEVELOPMENT

> Over 45 years of experience in heavy manufacturing, process design, manufacturing R&D, troubleshooting, production development, process engineering, shop fabrication, prototype assembly, pilot line development, hand-crafted assembly, refurbishment and repair of nonmetallic and metallic structures, first articles, and mixed material assemblies for a variety of industries from large scale aerospace vehicles to small consumer products including composite lay-up, autoclave curing, plastics compounding, coatings formulation, resin processing, polymer crosslinking, coating deposition, ball milling, slurry processing, surface finishing, lamination, film conversion, packaging, resin infusion/impregnation, high temperature conversion and CVD/CVI/CVC processing up to 4500°F, soldering, electronics fabrication and PCB assembly. Exceptional skills in bench level R&D and the scale-up of new products and processes from the laboratory to production.

METALLURGY AND CORROSION SCIENCE

> Long-standing expertise in metal materials science with hands-on skills in the electrochemistry of (a) corrosion processes and mitigation of galvanic, pitting, intergranular, stress and crevice corrosion, and embrittlement phenomena, and (b) state-of-the-art plating and metal finishing technologies including anodizing, passivation, conversion, electrolytic and electroless plating, (c) hexavalent Cr-free coatings, environmentally-compliant and leading-edge anti-corrosion technologies, (d) intermetallic compound precipitation and intergranular migration, (e) organometallic complex formation, chelation and ligand interaction, and (f) potentiodynamic polarization analysis of general and pitting corrosion, passivation, repassivation, oxide growth kinetics and long term corrosion prediction, as well as (g) heavy shop fabrication involving machining, heat treatment, hardening and analysis of wrought, cast and extruded low-alloy steels, austenitic/martensitic stainless steels, Al alloys, Ti alloys and the Ni-Cr super alloys.

FAILURE ANALYSIS & RELIABILITY

> Multi-disciplinary expertise in forensic-style, root-cause failure analysis, corrective action application, quality science, reliability design and reliability testing for mixed material, mixed technology platforms comprised of composites, fibers/fabrics, resins, adhesives, sealants, polymer coatings, inorganic coatings, metal coatings, molded plastics, ceramic bodies, ceramic coatings, glass coatings, graphite structures, carbon coatings, passivated metals, active metals, super alloys, fasteners, electronic components, circuit boards and PCB assemblies. Implemented Six Sigma tools for defects eradication, lean processing, cost and waste reduction. Resolved customer return failures, conducted product qualifications and reliability evaluation programs for small components to large aerospace vehicles. Established, equipped and managed multiple laboratories for failure, reliability and quality analysis.

ELECTRONIC & MAGNETIC MATERIALS

> Expert hands-on skills in electronics technology including failure analysis, packaging technologies, components engineering and reliability engineering from the die level up as well as manufacturing process engineering, silicon wafer fabrication, telecom and computer system assembly from the board level up, mixed technology manufacturing, manual and auto-installation of SMT chips, wireless RF devices, LEDs, wire bonds, discretes, semiconductors, connectors, hybrid circuits, harnesses, antennae, housings and peripherals. Special skills in advanced packaging materials and processes, component deprocessing and disassembly as well as conformal coating technologies, magnetic phenomena and high coercivity ferromagnetic systems, electromigration processes through metals, joints and across dielectric surfaces, solderability science, alternative solder and flux compositions, intermetallic compound formation and migration, contamination control, laminated and 3-D PC board technology.

WORK SUMMARY

SR. MATERIALS SCIENTIST, Composites, Polymers, Ceramics and Corrosion Engineering Directorates
Jacobs Technology . . . NASA/Marshall Space Flight Center, Huntsville, AL . . . May 2007 – Current

> Lead Materials Chemist, Task Lead, and Nonmetallic Scientist supporting NASA R&D efforts and SBIR projects for the design, manufacture and analysis of next-generation rocket systems, space telescopes, interplanetary probes and spacecraft vehicles. Senior specialist for investigations into novel polymers, protective coatings, advanced composites, corrosion mitigation, surface finishing, ceramics, adhesives, failure analysis and manufacturing design. Oversaw laboratory design, pilot line layout, advanced materials processing equipment and facility requirements for NASA's new state-of-the-art R&D laboratory building. Independently developed floor lay-out, equipment and facility requirements for NASA's new pilot laboratory for development and fabrication Carbon/Carbon, Ceramic Composites, Ablatives, new and innovative high temperature composite designs and prototypes.

> Subject Matter Expert and Senior Advisor for the formulation, curing/crosslinking, coating, pyrolysis, out-of-autoclave curing approaches, alternative fiber precursors, thermal decomposition and conversion of phenolic resoles, liquid crystal polymers, preceramic polymers, siloxanes, silanes, next-generation reinforced elastomers, mesophase pitch, glassy carbon, graphite, high char mesogenic thermoplastics and thermosets as high char precursors.

> Principal Investigator, Electrochemist and Plating SME evaluating anti-corrosion mechanisms, alternative plating technologies, polarization techniques, passivation and oxidation growth kinetics, chromate and anodic surface conversion, novel primers and coatings, galvanic compatibility, pitting rates, stress corrosion, embrittlement, and environmentally progressive alternatives for enhanced corrosion protection on an array of active and noble metals including the Al alloys, alloy steels, SS, the Ti alloys and Ni/Cr super alloys such as Inconel, Hastelloy and Nitinol.

SR PROCESS DEVELOPMENT ENGINEER, Composites Center of Excellence and Metals Center of Excellence
Bell Helicopter Textron Inc . . . Fort Worth, TX . . . June 2004 – August 2006

> Resolved materials and production issues, and conducted failure analysis during large scale fabrication and floor manufacturing of epoxy, BMI and cyanate ester composite structures, bonded metal/composite assembles, fabrication and finishing of alloy steels, SS and Al components for commercial, military and tilt-rotor aircraft. Oversaw the Root Cause Analysis / Corrective Action system in the Composites and Metals Centers of Excellence.

MANAGER, FAILURE ANALYSIS & RELIABILITY LABORATORY, Materials Analysis & Quality Engineering
RF Monolithics Inc . . . Dallas, TX . . . February 2001 – June 2004

> Senior Analysis Manager reporting to the SVP with responsibility over the QA Lab, failure analysis, reliability engineering, product/process qualifications and materials characterization in support of manufacturing operations for sputtered Al/Ti die packaged in wireless, hermetically sealed RF surface acoustic wave (SAW) transceiver components, hybrid modules and circuit assemblies used in the commercial, industrial and defense industries.

SR MATERIALS ENGINEER, Adhesives & Sealants, Advanced Systems & Aerostructures Design
Lockheed Martin Aeronautics Co . . . Fort Worth, TX . . . January 1998 – April 2000

> Project Manager for design investigations into new, emerging and alternative manufacturing technologies utilizing next generation sealants, adhesives, composites, primers, anodized coatings, bonding systems and reduced fastener approaches for high performance fuel containment on the F-22 and Joint Strike Fighter F-35 assembly concept. Streamlined procedures for the application of spray-on sealants, film adhesives, and metal-to-composite bonding.

CERAMICS & CARBON R&D ENGINEER, Carbon, Graphite & Ceramics, Materials R&D Group
Poco Graphite Inc . . . Decatur, TX . . . August 1996 – December 1997

> Lead Scientist and Process Development Engineer for hands-on pilot line R&D and production support with original innovations in ceramic adhesive formulation, preceramic polymer compounding, process development of polymer-derived ceramic articles, high temperature ceramics fabrication via CVC, high volume SiC LPCVD, bonding of graphite and ceramic components, pyrolytic carbon CVD/CVI, glassy carbon and graphite manufacturing (4500F°).

COATINGS R&D FORMULATION CHEMIST, Polymer Adhesive Coatings, Research and Technology Group
Graham Magnetics Inc . . . Graham, TX . . . February 1992 – August 1996

> Principal Scientist for experimental R&D and manufacturing development of solvent-based film adhesive coatings and fast-dry water-borne latex products derived from urethane/ester/ether/acrylate elastomers, particles, dispersions, emulsions and state-of-the-art surfactants processed through compounding, blending, ball milling, sand milling, kneading, web/flow coat deposition, hot roll calendaring and flexible film conversion. Pioneered, formulated, optimized and scaled-up original magnetic polymer coating system providing 60-80% VOC reduction (unpatented).

SR. MATERIALS & PROCESS ENGINEER, Advanced Manufacturing Technology & Components Engineering
Motorola Comm Sector . . . Fort Worth, TX . . . June 1988 – January 1991

> Lead Failure Analyst, Process Development Engineer and Materials Chemist for daily manufacturing of telecom systems from the board level up. Documented failure mechanisms during production and for field returns, oversaw reliability testing, and managed the instrumental and wet chem analysis laboratories. Resolved process issues during line operations, developed new procedures and authored process specifications for PCB conformal coating.

COMPOSITE MATERIALS SCIENTIST R&D ENGINEER, Advanced Carbon-Carbon Technologies, Space Programs
LTV Aerospace & Defense Co . . . Dallas, TX . . . September 1982 – April 1988

> Principal Investigator for the design, formulation and hands-on manufacturing development of the original Advanced Carbon-Carbon (ACC) composite material system and refinement of the first generation Reinforced Carbon-Carbon (RCC) used on the Space Shuttle's Leading Edges. Pioneered original methods for state-of-the-art fabrication and characterization of polymer matrix composites and ceramic-coated carbon-carbon structures (unpatented).

ELECTROLESS PLATING R&D CHEMIST, Coatings & Metal Finishing Dept., Plating Development Laboratory
Pressure Vessels Inc . . . Fort Worth, TX . . . July 1978 – January 1981

> Lead scientist for experimental R&D into new formulations for aqueous metal deposition technologies. Formulated, troubleshooted and maintained the company's 200,000 gallon metal finishing line comprised of E-Ni, phosphate and chromate conversion. Innovated original products for ligand-catalyzed E-Ni-P, E-Cu, E-Ni/Cu, E-Ag, E-Au, E-Pd, E-Sn and E-Co (all unpatented) and conducted early development trails on E-Ni/SiC, E-Ni/PTFE, E-Cr and E-Ti.

> **Analytical Chemist –** Industrial Laboratories Inc., 1991. Conducted hands-on wet lab, titrametric and instrumental techniques evaluating industrial processing solutions, soils, cement, wastewater, BOD, metals, resins, plastics, etc...

> **Process Development Engineer –** Teccor Electronics Inc. 2000. Oversaw operations for processing of Si wafers utilizing plating, spin glass deposition, dicing, plasma etch and pre-package fluidized soldering.

> Impact Composites Inc., 2001 – Provided hands-on consultant services regarding fabrication, design and advanced chemistry issues, and new and emerging technologies for glass fiber-reinforced articles and structures.

> Composite Technology Inc., 1991 – Provided hands-on consultant services regarding fabrication, design and advanced chemistry issues, and new and emerging technologies for glass fiber-reinforced articles and structures.

> Materials Science, 2003. Conducted hands-on, self-directed R&D investigating original composite formulations for lightweight concrete comprised of polymers, fibers, performance additives, novel admixtures and Portland cement.

EDUCATION & TRAINING

> Master of Science candidate in **Chemistry** at UAH, Huntsville, AL, 2009 – 2011, GPA 3.7

> Master of Science coursework in **Materials Science & Engineering** at UTA Arlington TX, 2002-2003, GPA 3.5

> Bachelor of Science in **Chemistry** . . . University of Texas at Arlington . . . received 1982

> Five hours short of B.A. **Physics,** UTA, 1982

> Frontiers in Inorganic Polymers, American Chemical Society short course

> Management & Leadership Skills for Front Line Managers, National Seminars Group short course

> Process Failure Modes & Effects Analysis, ISO/QS Inc short course.

> Semiconductor Processing Overview, Texas A&M Extension

> Motorola corporate training: Design for Six Sigma, Design of Experiments, SPC, Scanning Electron Microscopy (40 hrs, JEOL), Physics of Failure and Reliability Physics.

MATERIALS SCIENCE & PROCESS DEVELOPMENT SECTIONADDITIONAL SKILLS & EXPERIENCES

COMPOSITE MATERIALS SCIENCE

> ORIGINAL INNOVATION – NEXT GENERATION C-C COMPOSITES

Developed and refined the original Advanced Carbon-Carbon (ACC) composite material system, second generation to the Space Shuttle's Leading Edge Reinforced Carbon-Carbon (RCC) composite thermal protection system. Industry pioneer in leading edge PMC, C-C and CMC technologies with the proven ability to design, formulate, characterize and manage the fabrication of advanced composite structures that are superior to current state-of-the art methodologies. Unparalleled expertise with a quintessential vision for the development of Next-Generation C-C materials (NCC, nomen novum), PMC, CMC and CFC platforms that can survive extreme conditions (unpatented).

> COMPOSITE MANUFACTURING OVERVIEW

Innovated new procedures for biased and balanced cross-ply laminate lay-up, single and double vacuum bag assembly, vacuum/pressure resin transfer impregnation, compression molding, casting, secondary bonding and repair technologies. Evaluated process parameters for pultrusion, prepreg/tape winding, filament winding, fiber/tow placement, matched die molding, double bag infusion and lamination, spray-up of resin/fiber mixtures, formation of carbon aerogels and ceramic sol gels, and damage-mitigated machining operations. Investigated state-of-the-art fabrication methods for co-cured and co-bonded blade-stiffened, honeycomb, corrugated and trusscore-stiffened sandwich structures comprised of carbon/epoxy, aramid/phenolic, ceramic/carbon, ceramic/ceramic, Al and C-C.

> PROCESS TROUBLESHOOTING

Expert process engineering skills and failure analysis methods for the resolution of large scale manufacturing issues and material defects including the adverse effects of hot vacuum debulking practices which lead to resin solution separation; inadequate post-cure awareness and improper implementation which increase residual stresses, residual volatiles and delamination probability; impetuous machining practices, pinning and stitching which damage fibers and reduce reinforcement integrity. Resolved problems due to inadequate cure cycle profiles and wide temperature variations during co-curing operations, out-of-plane degree-of-cure inconsistencies, defective bleeder/breather configurations, incomplete volatile removal, resin-rich and resin-starved conditions, ply separations, intrinsic

fiber/fabric defects, in-plane and out-of-plane fiber/fabric distortions, bridging, misalignment, wrinkles and marcels, fiber-matrix debonding, fiber fracture, microbuckling, fiber pill, brooming and fraying, matrix cracking, in-process delaminations, latent delams and weak planes that are designed-in or manufacturing-induced which progress into fractures later in the field, excessive porosity and voids, closed porosity and localized pore clusters, fiber bundle porosity, interstitial porosity, incompatible tooling designs, mandrel material compatibility, etc . . .

> SPECIAL ACHIEVEMENTS & INNOVATIONS

Distinguished accomplishments and self-directed R&D efforts have included experimental development of original composite process characterization models, delamination eradication via special techniques for residual stress reduction and savvy post-cure methodologies, development of novel interlaminar techniques for enhanced Mode I (ILT) and Mode II (ILS) toughness, formulation of high performance binders and matrix resins for improved fiber surface wetting and bundle penetration throughout the reinforcement network, development of original methods for vacuum bag polymer/resin infusion into fabrics and porous substrates, optimization of special techniques to reduce porosity, facilitate pore interconnectivity and control the distribution of fiber volume and resin content, formulation of low friction Ni/PTFE tooling surface finishes, development of rapid PIP densification techniques (successive cycles of impregnation and pyrolysis) as concepts for next-generation 2D and 3D C-C and CMC substrates.

POLYMER MATERIALS SCIENCE

> ORIGINAL FORMULATION – FLEXIBLE POLYMER COATINGS

Experimentally formulated, developed and scaled-up original adhesive coating products based on water-reduced lacquer/latex hybrid polyurethane/polyester and urethane/polyether dispersions as well as improved solvent-based systems derived from novel functionalized prepolymers, state-of-the-art surfactants, additives and particles processed via compounding, blending, milling, extrusion, calendaring and flexible film conversion (unpatented).

> OVERVIEW OF POLYMER FAMILIES

Subject Matter Expert in the chemistry, formulation and processing of monomers, prepolymers, elastomeric and semi-flexible networks of TDI/MDI and non-isocyanate-crosslinked urethanes, phenoxy/urethanes, epoxy/urethanes, crosslinked polyesters, phenolic/epoxies, phenolic/NBR, silyl-terminated urethanes and polyesters, urethane-acrylates, EPDM, PVC, fluoropolymers, polysulfides, chlorosulfonated rubbers, polysilanes, siloxanes, silicones, and water-based emulsions/dispersions of the above, as well as highly aromatic thermoplastic and semi-thermoset mesogenic cyanate esters, polyimides, aramids, ether imides, ether ketones, phenylene oxides and benzimidazoles.

> PROCESSING OF POLYMERS & RESINS

Developed original techniques for vacuum-pressure resin infusion, impregnation, lamination, compression molding, matched die molding, open mold, flow coating, spray coating, slurry processing, adhesive bonding, dispersion and emulsion processing, and nanocomposite sol-gel formation. Evaluated advanced methods for esterification, condensation, grafting, free radical, crosslinking, mixed polymer blending, compounding, extrusion, machining and semicrystalline amorphous hydrogel formation. Improvised methods to enhance thermal and mechanical properties for products comprised of thixotropic elastomers, thermoplastics, semi-crosslinked gels, high crosslink thermosets, and semi-thermosets comprised of hard and soft segments with variable functionality and molecular weight.

> LABORATORY & RESEARCH TECHNIQUE

As Principal Investigator, created, established and managed multiple state-of-the art laboratories and pilot lines over the years for conducting self-directed R&D, new product formulation, materials processing, DOE, manufacturing development, prototype fabrication, test method development and scientific analysis via instrumental, wet lab analysis, failure analysis and reliability testing in the areas of organic/inorganic polymer systems, elastomers, resins, adhesives, sealants, surfactants, coatings, composites, ceramics, electrochemistry, corrosion and metallurgy.

> CHEMICAL & PHYSICAL CHARACTERIZATION

Hands-on techniques have included FTIR, TGA, DSC, TMA, DTA, SEM, EDX/WDX, GC/MS, HPLC, IC, XRF, GPC, UV/VIS, AA, ICP, viscometry/rheometry, wet lab chemical analysis, particle size/distribution analysis, NDE, X-Ray, ultra-sonic, cross-sectioning/polishing, microphotography, salt spray, accelerated life testing, HAST, dynamic surface tensiometer, contact angle goniometer, surface roughness, quartz dilatometry, mercury porosimetry, helium pycnometry, ASTM-modified 3pt/4pt flexure, tensile, compressive, short beam shear, lap shear, interlaminar shear, interlaminar tensile, adhesion/cohesion peel, pull and ballistics impact. Special skills for test methods development, modified ASTM/ANSI approaches and innovative characterization methodologies.

> ORIGINAL RESEARCH ACTIVITIES

Special R&D topics have included experimental formulation of flexible polyester thermosets as original composite binders; silyl-terminated polyurethane/nanoparticle dispersions for environmentally-friendly adhesive coatings; mesogenic phenolic resins with elevated glass transition temperature and char yield; Ni-coordinated oligomer dispersion complexes as potential candidates for ferromagnetic polymers; and polysilane/siloxane thermoset compounds and coatings with high ceramic yield via pyrolytic crosslinking. Investigated creative methodologies to control functional group composition, branching strategy, inter/intramolecular interactions, terminal group coupling, main chain and pendant group crosslinking sites, design of specially functionalized polyhedral oligomeric silsesquioxane (POSS) compounds as novel polymer systems and formulation additives, synergistic surfactant formulations, manipulation of surfactant-polymer interactions, and alternative methodologies for fiber synthesis.

CERAMICS & CARBON MATERIALS SCIENCE

> ORIGINAL FORMULATION – POLYMER DERIVED CERAMICS

Experimentally formulated, developed and fabricated SiC, Si_3N_4 and SiOC ceramics from preceramic polymers, powders and slurries for high temperature coatings, bonding agents and densification/impregnation of porous substrates and ceramic matrix composites (unpatented). Subject Matter Expert in the reactions, mechanisms and processing of polycarbosilanes, siloxanes, metal oxycarbides, polysilanes, silazanes, and reaction-bonded phenolics.

> CERAMICS & CARBON PROCESSING OVERVIEW

Improvised advanced methods for mixing/milling, compression molding, thick film casting, calendaring, sintering, rapid pyrolytic conversion, pack mix formulation and cementation, gaseous ceramicization of green bodies and ceramic precursors, ceramic-to-ceramic bonding, ceramic-to-carbon reaction bonding, liquid and vapor ceramic coating, densification of porous substrates, fabrication of refractory ablatives and development of graded ceramic layers on non-ceramic substrates. Hands-on expertise in vitrification of amorphous glassy carbon and glassy ceramics followed by 3000°-4000°F conversion into isotropic polycrystalline monoliths, 4500°F graphitization of green carbons, sol-gel processing, design and optimization of firing/pyrolysis profiles and furnace/kiln modifications. Experimentally evaluated LPCVD/CVI and CVC techniques for the formation of β-SiC and α-Si_3N_4 bodies and coatings from bulk graphite, pyrolytic carbon, novel carbonaceous and silicon precursors.

> PARTICLES, POWDERS & SLURRY FORMULATION

Investigated new techniques and equipment for slurry processing, particle grinding, ball milling, sand milling and high shear mixing of masterbatch slurries formulated from powders, gels, solvents and thixotropic binder solutions. Characterized dry powders in bulk as well as the specific properties and formulation effects of acicular, discoidal and nanoparticles. Developed techniques to control factors such as particle shape anisotropy, particle size distribution, particle alignment, packing fraction, pigment volume concentration and interparticle interactions. Developed techniques to improve particle suspension, electrical double layer composition, solvent-water compatibility, hydrophile-lipophile balance, emulsion stabilization, surface tension, contact angle, surface charge activity, chemical coupling, and the interactions between functional binder segments and active substrate surfaces.

> ORIGINAL RESEARCH ACTIVITIES

Special R&D topics have included experimental formulation and process development of liquid ceramic compounds as binders, bonding agents and coatings, glassy/amorphous and polycrystalline polymer-derived ceramics, oxidation-resistant ablatives and refractories, TEOS glass chemistry and sol gel processing, metal oxide growth processes on active metals, pore structure definition and porosity densification techniques for ceramics, carbon and mixed ceramic/carbon/graphite structures, CVC of carbon/graphite bodies into monolithic β-SiC, functionally graded diffusion layering techniques for ceramics on graphite and composites, and cermet-to-metal conversion coatings. Investigated differential CTE phenomena in mixed material systems and improvised methods to mitigate CTE mismatch and thermal shock effects. Developed unique tools to elucidate the reactions and mechanisms during thermal decomposition, pyrolytic conversion and the evolution of heat-affected transition zones in charred materials.

MANUFACTURING PROCESS DEVELOPMENT

> PRODUCT/PROCESS SCALE-UP & MANUFACTURING R&D

Innovated and developed new products and processes in small batches and oversaw scale-up on manufacturing pilot lines in the areas of state-of-the-art composite structures, bonded assemblies, and high performance polymer coatings, metallic coatings and magnetic coatings. Identified nonlinear scale-up parameters, batch-to-batch inconsistencies and troubleshooted the upgrade process from bench level R&D to semi-scale production. Developed original process characterization tools and process design models to define the evolution of material attributes through each process phase and to generate predictions regarding key product properties for finished goods.

> PROCESS ENGINEERING & PRODUCTION DEVELOPMENT

Troubleshooted recurring issues, improvised workarounds, reduced manufacturing costs, consolidated process steps, developed innovative improvements, authored materials and process specifications, and designed new procedures in the areas of plating/metallization, plastics fabrication, structural bonding, electronics manufacturing, composite assembly, ceramics fabrication, powder slurry processing and polymer coating application via spray, immersion/dip and flow-coat deposition. Evaluated new approaches to enhance product/process quality, manufacturing flow, maintenance requirements, waste generation and environmental impact for a myriad of industries over the years.

> INDUSTRIAL PROCESSING & MATERIALS HANDLING

Heavy shop experience in large scale composite manufacturing, metal fabrication, hardening and finishing, machining, bonding, fastening, plastics processing, polymer coating, spray/flow/dip/vapor deposition, ball milling, reaction processing of polymers, resins, powders and slurries (thousands of pounds), pyrolysis, high temperature conversion, ceramicization and graphitization (> 4000°F). Daily use of materials in bulk including resins, gels, fibers, fabrics, waxes, pellets, particles, powders, acids, bases, oxidizers, reducers and solvents such as acetone, toluene, chloro/fluoro carbons, IPA, THF, MIBK, MEK, HCl, H_2SO_4, HNO_3, H_3PO_4 and NaOH (thousands of gallons). Hands-on involvement in metal finishing, composite fabrication, fill & fare, machining, priming, bonding, sealing, chemical processing, refurbishment and repair operations since age thirteen (family owned business).

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