Myoung-Gyu Lee

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EDUCATION

Ph. D in Materials Science and Engineering, January 2004
Seoul National University, Seoul, Korea

M.S. in Fiber and Polymer Science, January 1999
Seoul National University, Seoul, Korea

B.S. in Fiber and Polymer Science, January 1997
Seoul National University, Seoul, Korea

Qualifications

- **Continuum mechanics:** Strength of materials, Metal plasticity, elasticity, visco-elasticity, continuum based crystal plasticity, anisotropic yield function, non-linear cyclic hardening
- **Materials:** Magnesium alloys, Advanced High Strength Steel (AHSS), Dual-phase steel, Aluminum alloys, Polymer composites, Thin glass, Electrical materials such as Tantalum, TRansformation Induced Plasticity (TRIP)
- **Micro structure:** Theory of Dislocation, deformation texture, strengthening mechanism
- **Advanced FEA modeling:** Press hardening (Hot stamping), nonlinear structural, dynamic stress, crystal plasticity, meso-scale simulation, crashworthiness, forming, springback, residual stress, contact problems, heat transfer, handling of user subroutine of commercial FE software
- **CAE, solid modeling:** ABAQUS, ANSYS, Dyna-3D, Pam-Stamp, Hyper-mesh, Patran, I-deas
- **Programming languages:** Fortran 77/90, C/C++, Html, Matlab, Mathematica
- **Mechanical/material characterization:** Tensile/compressive, cyclic tests, impact test, forming/springback tests, bending/torsion tests, Microscopes, X-ray, OIM
- **Communication skills:** proposal, report, paper writing; public presentations; work coordination

PROFESSIONAL ORGANIZATIONS, SERVICES

The Minerals, Metals and Materials Society (TMS)
Editorial board of Korean Society for Technology of Plasticity
Reviewer of International Journal of Plasticity
Reviewer of International Journal of Solids and Structures
Reviewer of Transactions of Materials Processing (Korean)

EXPERIENCE

- **Senior Researcher**, Korea Institute of Machinery & Materials, Korea, May 2007~ present
- **Post-doctoral Researcher**, Supervisor: Prof. Robert H. Wagoner, The Ohio State University, U.S.A, October 2004~ April 2007
- **Post-doctoral Researcher,** Supervisor: Prof. Peter M. Anderson, The Ohio State University, U.S.A, May 2005- April 2007
- **Post-doctoral Research Fellow**, Supported by the BK21 (Brain Korea 21), Seoul National University, Korea, March 2004~ September 2004.
- **Graduate Research Assistant (Ph.D)**, School of Materials Science and Engineering, Seoul National University, Seoul, Korea, March 1999~Feb. 2004
- **Graduate Research Assistant (MS)**, Department of Fiber and Polymer Science, Seoul National University, Seoul, Korea, March 1997~Feb. 1999
- Commercial and research projects were sponsored by General Motor company, Cabot corp., POSCO, Samsung-Corning Precision Glass (Korea) and Air force Office of Scientific Research (AFOSR), NSF. Field of study ranges from mechanical testing to numerical simulation, and from micro-structure to macro property of materials.

1) Modeling and Design Experience:

- Developing a **finite element analysis for the press hardening** considering plasticity by the phase transformation of steel (on going)
- Investigate constitutive behavior of **Transformation Induced Plasticity** (TRIP)
- Developed **a new finite element formulation for the elasto-plastic strain rate potential**, srp2004.
- Developed a **meso-scale simulation** procedure to study the strengthening mechanism of metallic materials. The new simulation unit which simulates dislocation density pileup and transmission near the grain boundaries revealed that the high dislocation densities near the grain boundaries are responsible for the size dependent strengthening like Hall-Petch relation.
- **Stress-strain response of nanocrystalline materials** by Finite Element Method based on rate-dependent crystal plasticity. Investigate grain size effect and grain spatial distribution effect on the mechanical response of nanocrystalline material by the **binary plastic transformation rule**. The method will be applied to study the **phase transformation of shape memory alloy** (cowork with Peter M. Anderson at OSU)
- Developed **crystal plasticity finite element program** to optimize the deformation texture after upset of Tantalum material. Various sensitivity tests were carried out to investigate the effect of process (friction, upset speed) and material (rate sensitivity, hardening rate etc.) on the final upset texture and stress-strain response.
- Develop novel hardening model for **AZ31B magnesium alloy** sheet. Unusual **asymmetry** in tension and compression is incorporated into the novel two-surface model. The developed constitutive equations have been implemented into finite element program.
- Originated a process/material optimization method to reduce **sheet metal springback** after forming. The new constitutive equations were developed and implemented into commercial FE program **ABAQUS** via

User Material Subroutine, **UMAT/VUMAT**. The new model along with non-linear hardening and non-quadratic yield potential showed advantages in prediction capability in the automotive industry.

- Developed **combination type isotropic-kinematic hardening model** to better predict the cyclic behavior of light-weight sheet materials such as aluminum alloys and high strength dual-phase steel. The developed constitutive equations were mathematically formulated and implemented into FE program.
- Conducted a series of FEA simulations to improve **crashworthiness** of automotive parts. These include numerical sensitivity study on both material and process parameters.
- Conducted **thermo-mechanical FE simulations** to reduce the bowing phenomenon in production of thin LCD glass. Visco-elastic constitutive equations were implemented into static FEM program and sensitivity tests were performed for the speed of inflow glass melt, upwind speed, speed of side roller etc.
- Introduced anisotropic **visco-elasticity** to design high stiffness fiber reinforced composite C-shaped ring. The analytical and numerical modeling techniques were developed to design the medical device for the fixation of broken or abnormal bone.
- Developed **robust contact algorithm** to reduce computational expense in simulation of sheet metal forming. The research oriented FE code **SHEET-3** originally developed at OSU was modified to include more capabilities such as draw bead, general tool surfaces etc.

2) Materials and Metallurgical Experience:

- Room temperature **cyclic tension/compression** tests and **drawbend springback** tests for **AZ31B magnesium alloy sheets**.
- Studied the **microstructural response of BCC metals** after tensile deformation using fine scale **Orientation Image Microscopy (OIM)** experiments which can capture the evolution of lattice curvature. Tensile tests, and rolling tests were conducted for mechanical properties. Co-worked with BYU (research group of Brent L. Adams)
- Conducted **time independent/dependent springback tests** (the OSU draw-bend tests, in R.H. Wagoner group) to study the springback phenomenon of several automotive sheets such as aluminum alloy and high strength steels.
- Developed a new **tension/compression test device** to prevent buckling during the compressive test of thin sheet metals. Performed cyclic tests using this device and characterized the unloading and reverse loading behavior of thin **aluminum** alloy, **magnesium** alloys and **DP-Steel** sheets.
- Conducted **bending test** of fiber reinforced composite C-ring. The results showed better prediction capability when the material is modeled with anisotropic visco-elasticity.
- **Fabricated fiber reinforced composites** including uni-axial laminates and 3-dimensional multi-axial braided structure. The mechanical properties of highly non-linear polymeric material were measured and utilized for a novel constitutive equations.

Skills

Language

- Have a good command of English

Computation

- Finite Element Program: ABAQUS (UMAT/VUMAT), SHEET-3 (OSU FEM Program), ANSYS, Dyna-3D
- CFD Program: FLUENT (Certificated user)
- Pre, Post Program: PATRAN, HYPERMESH, FEMAP, Gambit (Pre for Fluent)
- Programming, Math Program: FORTRAN (77, 90), C, C++, MATLAB
- Texture Analysis Software: popLA

Experiments

- Mechanical testing machine; Instron, MTS, Drawbend Tester (OSU)
- Impact tester
- Fabrication of composites materials: hot press
- Dilatometer

Selected publications

- **Lee MG** et al., "The Viscoelastic Bending Stiffness of Fiber-Reinforced Composite Illiazov C-Rings," **Composite Science and Technology** 61 (16) 2491-2500 (2001).

- Chung K, **Lee MG**, Kim D, Kim C , Wenner ML, Barlat F, "Spring-back Evaluation of Automotive Sheets Based on Isotropic-Kinematic Hardening Laws and Non-Quadratic Anisotropic Yield Functions, Part I: Theory and Formulation", **Int. J. Plasticity** 21 (5) 861-882 (2005).

- **Lee MG**, Kim D, Kim C, Wenner ML, Wagoner RH, Chung K, "Spring-back Evaluation of Automotive Sheets Based on Isotropic-Kinematic Hardening Laws and Non-Quadratic Anisotropic Yield Functions, Part II: Characterization of Material Properties", **Int. J. Plasticity** 21 (5) 883-914 (2005).

- **Lee MG**, Kim D, Kim C, Wenner ML, Chung K, "Spring-back Evaluation of Automotive Sheets Based on Isotropic-Kinematic Hardening Laws and Non-Quadratic Anisotropic Yield Functions, Part III: Applications", **Int. J. Plasticity** 21 (5) 915-953 (2005).

- Boger RK, Wagoner RH, Barlat F, **Lee MG**, Chung K, "Tension/Compression Testing of Sheet Material", **Int. J. Plasticity** 21(12) 2319-2343 (2005).

- **Lee MG**, Kim JH, Ryou H, Chung K, Youn JR, Kang TJ, "Numerical Implementation of Modified Coulomb-Mohr Yield Criterion for Anisotropic and Asymmetric Materials", **Fibers and Polymers** 7(3) 276-285 (2006).

- **Lee M**, Wang J, Anderson PM, "Texture Development in BCC Metals During Upset Deformation", **Materials Science and Engineering A 463(1-2)** 263-270 (2007).

- **Lee MG**, Kim D, Chung K, Wagoner RH, "Springback Prediction Based on Two-Surface Model", **Int. J. Plasticity** 23 1189-1212 (2007).

- **Lee MG**, Wagoner RH, Lee JK, Chung K, Kim HY, "Constitutive Modeling of Anisotropic/asymmetric Hardening behavior of Mg alloy sheets", (in

print) **Int. J. Plasticity** (May 2007)

- **Lee MG***, Kim SJ, Wagoner RH, Chung K, Kim HY, "Constitutive Modeling of Anisotropic/asymmetric Hardening behavior of Mg alloy sheets: application to sheet springback", **Int. J. Plasticity** (accepted) (Dec. 7, 2007)

- **Lee MG,** Kim D, Chung K, Wagoner RH, "Semi-analytic hybrid method to predict springback in draw bend test", **ASME J. Appl. Mech.** 74 1264-1275 (2007)

- Kim JH, **Lee MG** , Ryou H, Chung K, Youn JR, Kang TJ, "Development of Nonlinear Constitutive Laws for Asymmetric/Anisotropic Glass/Kevlar Fiber Reinforced Composites", (in print) **Polymer Composites** (January 2007)