Keynote Lecture

Title	Dr.	First Name	Sunghun	Last Name	LEe
Affiliation			Korea Institute of Materials Science		
Presentation Title			Pre-Oxidation Effects on the Thermal-Fatigue Behavior of Thermal Barrier Coatings		
Biography			Resume • Name: Sunghun Lee, Ph.D. • Date of Birth: 1971 • Place of Birth: Gimhae, Gyeongsangnam-do, South Korea • Current Position: Principal Researcher, Extreme Environment Coating Team, Extreme Materials Research Institute, Korea Institute of Materials Science (KIMS) • Years of Experience: Over 30 years in high-temperature materials, surface engineering, and aerospace coatings • Education: - B.S. in Materials Science and Engineering, Changwon National University, 1994 - M.S. in Materials Engineering, Changwon National University, 1996 - Ph.D. in Materials Engineering, Tohoku University (Japan), 2009 • Career: - 1996–Present: Korea Institute of Materials Science (KIMS), specialized in surface engineering • Research Expertise: - High-temperature oxidation - Thermo-fluid simulation - Advanced ceramic and metallic coatings • Key Technologies: - Thermal Protection System (TPS) - Thermal Barrier Coatings (TBC) - Thermal Management Coatings (TMC) • Research Interests: - Highly endurable coatings for extreme environments		

• Technical Skills:
- PVD thin film processing
- Thermal spray coating (including plasma spray)
- High-rate thick film fabrication using EB-PVD
- Charicterization and evaluation for coatings

• Leadership Roles(current):
- Vice President, Korea Thermal Spray Association (KTSA)
- Key member, Extreme Materials Characterization Research Complex Planning Committee (KIMS)

Professional Bio

Dr. Sunghun Lee, born in 1971 in Gimhae, South Korea, is a Principal Researcher at the Extreme Environment Coating Team of the Extreme Materials Research Institute, Korea Institute of Materials Science (KIMS). After completing his B.S. and M.S. in Materials Engineering at Changwon National University, he began his research career at KIMS in 1996 and earned his Ph.D. in Materials Engineering from Tohoku University in 2009.

With more than 30 years of experience, Dr. Lee specializes in surface engineering for extreme temperature environments. His research focuses on providing advanced coating solutions to enhance the reliability of systems and components operating under high thermal stress. His technical expertise includes high-temperature oxidation behavior, thermo-fluid simulations, and the development of advanced ceramic and metallic coatings.

He has been a driving force behind Korea's self-reliance in aerospace-grade thermal protection technologies, including Thermal Protection Systems (TPS), Thermal Barrier Coatings (TBC), and Thermal Management Coatings (TMC). Notably, he named his surface

	engineering solution for supersonic environments 'Mach-Shield'. He is also actively involved in developing highly endurable coatings for plasma-resistant and wear-resistant conditions. Dr. Lee is well-versed in PVD, thermal spray, and EB-PVD thick film processing technologies and currently serves as Vice President of the Korea Thermal Spray Association (KTSA). He is also playing a key role in building the Extreme Materials Characterization Research Complex within KIMS.

Abstract	This keynote will synthesize the state of the art on pre-oxidation for thermal barrier coatings (TBCs) and then introduce our recent EB-PVD studies that map processing–microstructure–lifetime links. From literature, pre-forming a thin, dense α-Al_2O_3 thermally grown oxide (TGO) can suppress transient θ/γ-Al_2O_3, reduce growth-stress and rumpling, and extend cyclic life—provided temperature–time–oxygen partial pressure are judiciously tuned. Building on this, we engineered TGO pre-growth on MCrAlY bond coats prior to 7–8 wt% YSZ top coats and quantified sensitivities: TGO thickness increases systematically with temperature (950→1100 °C) and pressure (0.5→3 mTorr), while a short pre-oxidation hold without oxygen has negligible effect. Under a standard furnace cyclic test (1100 °C, 50 min hot/10 min cool), benchmark EB-PVD TBCs spalled at ~700 cycles, whereas optimized pre-growth (e.g., 120 min, ≥1000 °C) yielded ≥800–925 cycles without spallation; pressure was comparatively less influential than temperature/time. Cross-sections reveal thicker, continuous α-Al_2O_3 (and late-stage spinel) with reduced interfacial cracking; an Al_2O_3 interlayer concept further tightened the TGO and curtailed crack initiation. We will conclude with a practical process map (T–t–pO_2) and design rules that couple pre-oxidation with graded/columnar architectures to target a sub-critical TGO thickness/roughness window for aero-engine duty, and outline open problems for modeling-assisted lifetime prediction.