Wonjin Yun, **Ph.D.**

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Education

Doctor of Philosophy in Energy Resources Engineering — *Stanford University*

Sept. 2014 - Jun. 2019 — *California, USA*

Thesis: *Advanced Microfluidic Framework for Understanding of Fluid-Flow in Porous Media: Microfabrication, Imaging, and Deep-Learning*

Master of Science in Petroleum Engineering — *Stanford University*

Sep. 2012 - Jun. 2014 — *California, USA*

Thesis: *Micro Visual Investigation of Polymer Retention in a Micromodel*

Bachelor of Science in Chemical Engineering | Higher Honor & Special Honor — *University of Texas at Austin*

Sep. 2008 - Jun. 2012 — *Texas, USA*

Undergraduate honor thesis: *Screen Factor - a simple way of characterizing viscoelastic property of EOR polymers*

Research Experience

Graduate Researcher | Stanford University Petroleum Research Institute-A — *Stanford University*

Sep. 2012 - Jun. 2019 — *California, USA*

- Research objectives :
  Reveal the underlying mechanisms relevant to the efficient production of hydrocarbon energy and water resources.

- Ongoing projects :
  Develop advanced visualization framework to pursue understanding micro-scale multiphase/viscous flow.
  Investigate mechanisms of micro-scale asphaltene aggregation in porous media during solvent-assisted oil recovery.
  Study wettability alteration of a surface in porous media by chemical additives (low-salinity water and surfactant).
  Enhance the applicability of polymer/surfactant/solvent injection as novel enhanced oil recovery (EOR) process.

- Microfabrication–microfluidic device :
  Achieved fully-digitalized framework for the flexible and fast design of microfluidic component (microchips and microchannels).
  Applied direct-write-lithography to enable rapid prototyping of new microchip designs for analysis of kinetics and fluid dynamics.
  Improved microfabrication to enhance structural realism of micromodel for a complex dual-porosity in carbonate rock.
  Modification of surface wettability and in-situ calcite growth to enhance geochemical realism of microfluidic model.
  Established integrated microchannel systems and advanced imaging techniques for micro-scale flow visualization.

- Flow characterizations–imaging and modeling :
  Pore scale non-invasive & *in-situ* viscosity monitoring of polymer flow in porous media via Spectral Laser Scanning Microscopy.
  Performed micro-Particle Image Velocimetry (μ-PIV) to investigate fluid-dynamics in a pore network.
  Applied Deep-Learning to enable fast/automated surface wettability classification of terabytes microscopic images data.
  Performed non-Newtonian flow simulation using OpenFOAM (partial differential equation solver).

Undergraduate Research Assistant | Gary A. Pope Enhanced Oil Recovery Lab — *University of Texas at Austin*

Mar. 2010 - May 2012 — *Texas, USA*

- Research Objectives :
  Conducted alkaline surfactant polymer (ASP) injection to evaluate/screen field-specific chemical EOR strategies.

- Methods :
  Investigated phase behavior to optimize surfactant formulation for a specific oil field.
  Developed skills of polymer filtration, polymer hydration, and ASP core flooding experiments.
  Experimental approaches for flow visualization using the integrated microchannel systems.
  Stability testing of polymer rheology at different conditions (salinity, temperature, and polymer concentration).
  Performed polymer characterization: dynamic, frequency, strain, and steady testing using a Rheometer.

- Impact :
  Optimized surfactant formulation and polymer solution for effective application of chemical EOR for specific oil fields.
  Successfully performed polymer injection during core flooding experiment enhancing the mobility of hydrocarbon for efficient EOR.
  Developed device for testing viscoelastic property of EOR polymer.

Undergraduate Research Assistant | Keith P. Johnston Research Group *University of Texas at Austin*

Sep. 2011 - Mar. 2012 *Texas, USA*

- Research Objectives :
  Study the stability and suspension of surface-modified iron oxide nanoparticle on sandstone.

- Methods :
  Analyzed the adsorption of nanoparticles (iron oxide) on sandstone using UV-Vis Spectrometer.
  Explored the relationship between surface-coating polymer on nano-particles and nanoparticle adsorption on rock material.

- Impact :
  Predicted and controlled the degree of retention of nanoparticles on sandstone.

Work Experiences

Stanford University Petroleum Research Institute-A (SUPRI-A) *California, USA*

Postdoctoral Scholar *July. 2019 - Present*

Assessment of Enhanced oil recovery (EOR) methods of an offshore oil field including polymer flooding and miscible gas injection.

Aramco Services Company: Aramco Research Center–Boston *Massachusetts, USA*

Graduate Intern *Jun. 2016 - Sep. 2016*

Investigated single nanoparticle detection / imaging methodology for efficient tracer detection.
Fluorescence microscopy to evaluate the efficacy of nanoagent for displacement of immiscible phase.
Surface modification of miniaturized micro-channel for varying surface tension and capillary force.
Raman spectroscopy and SEM for compositional analysis of modified surface.
Magnetic nanoparticle: SERS detection of fluorescein in a miniaturized salt-rich environment.

Aramco Services Company: Aramco Research Center–Boston *Massachusetts, USA*

Graduate Intern *Jun. 2015 - Sep. 2015*

Developed methodology for in-line detection of tracers from the chemical inter-well tracer test.
Designed SERS microfluidic-detection platform for monitoring of thermally degraded analytes.
Applied Surface-Enhanced Raman Scattering (SERS) for detection of water-soluble analytes.

Republic of Korea Navy *Pyeongtaek, S. Korea*

Military Service *Feb. 2005 - Apr. 2007*

Conducted encoding and decoding of confidential documents.
Received best performance recognition from a chief of military education.

Publications & Presentations

International Peer-Reviewed Journal

a. Microvisual investigation of polymer retention on the homogeneous pore network of a micromodel. (2015) **W. Yun** and A.R. Kovscek. *J. Pet. Sci. Eng.*

b. Controlled Design and Fabrication of SERS-SEF Multifunctional Nanoparticles for Nanoprobe Applications: Morphology Dependent SERS Phenomena. (2016) S. Chang, S. Eichmann, **W. Yun** et al. *J. Phys. Chem. C*

c. Creation of a dual-porosity and dual-depth micromodel for the study of multiphase flow in complex porous media. (2017) **W. Yun**, S. Roman et al. *Lab on a Chip*

d. Magnetic SERS Composite Nanoparticles for Microfluidic Oil Reservoir Tracer Detection and Nanoprobe Applications. (2018) S. Chang, **W. Yun** et al. Selected as a supplementary issue cover. *ACS Appl. Nano Mater.*

e. Toward Reservoir-on-a Chip: Multi-Scale Framework to Access Surfactants for Enhancing Oil Displacement in Carbonates Using $CaCO_3$-Coated Micromodel. (2018) **W. Yun**, S. Chang et al. *ACS Appl. Mater. Interf. (Under Review)*

f. Deep-Learning: Automated Surface Wettability Classification for Pore-Scale Images from Microfluidic Experiment. (2019) **W. Yun**, Y. Liu, A.R. Kovscek *In preparation*

g. Microfluidic approaches to reveal micro-scale dynamics of asphaltene aggregation in micro-porous media. (2019) **W. Yun**, A.R. Kovscek *In preparation*

International Conference Presentations

a. Addition of 3D realism to silicon-etched micromodels using dual-depth etching and μ-PIV. Presented at International Conference on Complex Fluids Flows in Porous Media. 12-14 Oct. 2015 — *Bordeaux, France*

b. Advances in Experimental Microfluidics for Improved Pore-Scale Understanding of Enhanced Oil Recovery Processes. Abstract (H41E-01) presented at 2018 AGU Fall Meeting. 10-14 Dec. 2018 — *Washington D.C., USA*

c. Automated *In-Situ* Wettability Characterization on Resevoir-on-a-chip Using Deep Learning. Presented at 13th International Symposium of Electrokinetics at Massachusetts Institute of Technology. 12-14 June. 2019 — *Cambridge, USA*

Invited Talks

a. Advanced Microfluidic Approach for Improved Pore-Scale Understanding of EOR Process. presented at China University of Petroleum in Beijing. 21 Sep. 2017 — *Beijing, China*

b. Advanced Imaging using Microfluidic Approaches for Analysis of EOR Process. Presented at Special Tech Seminar at PEMEX. 13 Dec. 2017 — *Mexico City, Mexico*

Involved project

a. Toward Reservoir-on-a-Chip: Fabricating Reservoir Micromodels by *in-Situ* Growing Calcium Carbonate Nanocrystals in Microfluidic Channels. (2017) W. Wang, S. Chang, A. Gizzatov — *ACS Appl. Mater. Interfaces*

Technical Skills

Flow characterization: μ-Particle Image Velocimetry, Laser Scanning Confocal Microscopy, Spectral Imaging, Raman Spectroscopy, Zeta-potential, UV-Visible Spectroscopy

Micro-Fabrication: High-Speed Direct Write Lithography, Optical Photolithography, ICP(Inductive Charged Plasma) Deep Reactive Ion etcher, Surface Profiler

Image processing: Automation by Deep-Learning (Convolutional Neural Network), Classification, Segmentation, Pattern Recognition, Edge Detection, ImageJ, Imaris

Software: R, Python, MATLAB, OpenFOAM (Open source computational fluid dynamics), AutoCAD Design

Honors & Awards

2017 **Third Place,** Society of Petroleum Engineers (SPE) Western Regional Student Paper Contest — *California, USA*
2012 **Scholarship Recipient,** The Kwanjeong Educational Foundation — *Seoul, Rep. of Korea*
2012 **Scholarship Recipient,** Korean-American Scientist and Engineer Association — *Texas, USA*
2011 **Undergraduate Fellowship,** Undergraduate Research Funds, University of Texas at Austin — *Texas, USA*
2010 **Distinguished College scholar and Medallion,** Honors Day at University of Texas at Austin — *Texas, USA*

Academic Projects

Weather Prediction: Machine Learning on Big Data

a. Feature selection by Generalized Linear Estimator (GLM) with a Gaussian distribution. — *May 2016*
b. Temperature prediction by Gradient Boost Estimator (GBM).

Clustering Music by Genres Using Supervised and Unsupervised Algorithms

a. Data transformation using a discrete Fourier transform (DFT). — *Dec. 2015*
b. Conducted supervised learning via R / CART (Classification and Regression Tree).
c. Performed unsupervised learning via K-means clustering.

Modeling Uncertainty in the Earth Sciences

a. Decision making on clean-up of oil spill causing varying probability of water contamination. — *Mar. 2014*
b. Realized geographical variations using Stanford Geostatistical Modeling Software (SGeMS).
c. A sensitivity analysis of the geophysical response with respect to SGeMS earth model.

Extracurricular Activity

Leadership Activity

Digital & Brand team officer, Stanford Energy Club (SEC) *09/15 - 09/16*

External Vice President, Korean Student Association at Stanford University *05/13 - 06/14*

Member, Engineering Leadership Team at The University of Texas at Austin *09/10 - 05/12*

Professional Activities and Services

Teaching Assistant, Fundamentals of Energy Resource Engineering at Stanford University *09/13 - 12/13*

Member, Society of Petroleum Engineers (SPE) and SPE golden gate chapter *09/14 - present*

Member, Bay Area Microfluidics Network *05/17 - present*

Member, Omega Chi Epsilon National Chemical Engineering Honor Society *09/10 - present*

Reviewer Duties, RSC Advances, Fuel, and Lab on a Chip