

PATRICK ZHANG

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EDUCATION AND TRAINING

B.S. Metallurgical Engineering, Northeastern University, Shenyang, China (12/81).

M.S. Metallurgical Engineering, Chinese Academy of Science, Beijing, China (10/84)

Ph.D. Metallurgical Engineering, University of Nevada, Reno (12/91).

RESEARCH AND PROFESSIONAL EXPERIENCE

Research Director Florida Industrial and Phosphate Research (FIPR) Institute, Florida Polytechnic University (4/93-present). Conducted over 23 research projects on phosphate mineral processing covering on-line analysis, gravity separation, flotation, acid leaching, and magnetic separation, including 5 major demonstration projects with capacity ranging from 1-5 tons per hour, in collaboration with research institutions and industrial companies; developed and commercialized a LIBS online analyzer for phosphate minerals, coarse particle flotation process, and a high-solids pumping strategy with substantial economic benefits to the industry; Chaired eight international conferences on phosphate mineral processing and waste utilization; Project lead under Critical Materials Institute (CMI) for research programs on recovery of rare earths from phosphate since 2013; led the Institute's mineral processing program to global prominence by conducting more than 20 in-house projects, managing over 80 research contracts, editing 8 books on phosphate processing, authoring numerous technical papers and book chapters, and delivering keynote/plenary speeches at technical conferences.

Research Associate University of Nevada, Reno (1/92-3/93). Enhanced the competitiveness of the school in research in cyanide wastewater treatment, processing of difficult-to-process gold ores, and photo-chemical destruction of contaminants. Earned high regards for both research and academic performance. Conducted metallurgical research projects.

Research Engineer KC&A, Reno, Nevada (5/90-2/93). Established the company's research capability in mineral flotation, high-temperature metallurgy and mineral bioprocessing. Secured research grants from mining companies for developing novel processes. Managed contractual research projects.

AWARDS AND HONORS

- **World's top 2% of scientists (2021, 2022, and lifetime since 2023)**
- **Chair, International Conference on Phosphate Processing (1996-present)**
- **Presidential and Provost Citations for Excellence in Research at Florida Poly.**

SELECTED PUBLICATIONS:

Zhang, P., 2023, Rare Earths in Phosphate: Characterization & Extraction, AGU Books, ESS Open Archive. doi: 22541/essoar.168554917.79526932/v1

Allaadini, G. and Zhang, P., 2019. Treatment of phosphoric acid sludge for rare earths recovery I: Effect of polymeric flocculant properties on filtration and recovery. *International Journal of Surface Engineering and Interdisciplinary Materials Science*, 7 (2), pp. 1-18.

Allaadini, G. and Zhang, P., 2019. Treatment of phosphoric acid sludge for rare earths recovery III: Comparison of sawdust filter aid as body feed with pre-coating. *Eurasian Mining*, No. 2. pp. 49–53.

Allaadini, G. and Zhang, P., 2018. Treatment of phosphoric acid sludge for rare earths recovery II: effect of sonication and flocculant solution temperature on settling rate. *Separation Science and Technology*, DOI: 10.1080/01496395.2018.1536715.

Liang, H., Zhang, P., Jin, Z., and DePaoli, D. 2018. Rare Earth and Phosphorus Leaching from a Flotation Tailings of Florida Phosphate Rock, *Minerals*, 8, 416; doi:10.3390/min8090416.

Wu, S., Wang, L., Zhang, P., El-Shall, H., Moudgil, B., Huang, X., Zhao, L., Zhang, L., Feng, Z., 2018. Simultaneous recovery of rare earths and uranium from wet process phosphoric acid using solvent extraction with D2EHPA, *Hydrometallurgy*, Vol. 175, pp. 146-153.

Liang, H., Zhang, P., DePaoli, D., 2017. Rare-earth Leaching from Florida Phosphate Rock in Wet-process Phosphoric Acid Production. *Minerals & Metallurgical Processing*, 34 (3), pp. 146-153.

Zhang, P., Liang, H., Jin, Z., DePaoli, D., 2017. The Ultimate Mineral Processing Challenge: Recovery of Rare Earths, Phosphorus and Uranium from Florida Phosphatic Clay. *Minerals & Metallurgical Processing*, Vol. 34, No. 4., pp. 183-188.

Liang, H.; Zhang, P.; Jin, Z.; DePaoli, D., 2017. Rare Earths Recovery and Gypsum Upgrade from Florida Phosphogypsum. *Minerals & Metallurgical Processing*, Vol. 34, No. 4., pp. 201-206.

Al-Thyabat, S. and Zhang, P., 2015. In-line extraction of REE from dehydrate (DH) and hemihydrate (HDH) wet processes. *Hydrometallurgy*, 153:30-37 (2015).

Zhang, P., 2014. Comprehensive Recovery and Sustainable Development of Phosphate Resources *Procedia Engineering* 83 (2014): 37 – 51

SYNERGISTIC ACTIVITIES

[1] Academic Leadership in Minerals Processing.

- Chaired the series of International Conference on Phosphate Processing with hands on technical program design and editing of eight (8) «Beneficiation of Phosphates» books based on conference papers.
- Authored chapters for four books: “Rare Earths in Phosphate: Characterization & Extraction”, «AGU Books on Rare Earths», 2023; Chapter 113. Phosphate Rock in «SME Mineral Processing & Extractive Metallurgy Handbook», 2023; “Flotation Chemistry and Technology of Nonsulfide Minerals” in «Froth Flotation: A Century of Innovation», 2007; Phosphate Chapter in «Industrial Minerals & Rocks (Book), 7th Edition», 2006.
- Editorial Board for technical journals of Minerals and International Journal of Mineral Processing.

[2] Pioneering Research in REE Recovery from Phosphate Processing

- Conducted the first most comprehensive REE characterization in Florida phosphate and documented REE potentials in various phosphate mining wastes and byproducts in 2009
- Coordinated a 10-year research program to develop REE recovery strategies from five unconventional REE feedstocks
- Led an effort to develop a processing flowsheet for production of high-purity REE metals using a phosphate mining byproduct, ready for pilot testing.

[3] Research Collaboration with Muti Institutions

- Served as Principal Investigator for a DOE-funded project (DE-FE00032123) involving Pacific Northwest National Laboratory (PNNL), Oak Ridge National Laboratory (ORNL) and Florida International University (FIU)
- Project lead for “Total Utilization of Phosphogypsum for Production of Rare Earths, Fertilizers and Construction Materials”, a project funded by the Critical Materials Innovation Hub (SC-24-596), with collaboration with Rutgers University, PNNL, ORNL and FIU
- Conducted a one ton per hour pilot testing project on separation of dolomite from phosphate, involving two engineering firms, three professors and a construction company.

[4] Contribution to Global Advances in Science and Technology

- Participated in a United Nations’ expert missions on uranium recovery from phosphoric acid. During this mission, the experts evaluated two pilot plants (one in Egypt and another in the Philippines) for uranium production and provided technical input for improvements.
- Actively involved in drafting of two international documents sponsored by the International Atomic Energy Agency. One document is on uranium recovery from phosphoric acid and the other on phosphogypsum (a huge phosphate mining waste) management and utilization.
- Member of Working Group on global phosphogypsum utilization organized by the International Fertilizer Association.