You Zhou

Assistant Professor

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Appointments

2021- Assistant Professor, *University of Maryland*

2015-20 Postdoctoral Fellow, *Harvard University*, advisor: Hongkun Park

Education

2015 Ph.D. in Applied Physics, *Harvard University*, advisor: Shriram Ramanathan

2010 B.S. in Physics, *Peking University*, Beijing, China

Research

Strongly interacting electrons and photons in low-dimensionam materials

- Demonstrated Wigner crystals in atomically thin semiconducting heterostructures without magnetic field; developed methods to electrically control their quantum phase transitions (Nature). The study was featured in Quanta Magazine, Journal Club for Condensed Matter Physics, and Chemistry World.
- Realized mirrors that are only three atomic layers (six angstroms) thick, leveraging strong interactions between electrons and holes in low dimensional materials (Phys. Rev. Lett.). Recently, using such mirrors we demonstrated ultra-compact and chiral optical nano-cavities, which constitutes a new type of photonic structure for engineering light-matter interactions (arXiv).
- Developed methods to independently control the population of Bosonic and Fermionic excitations in semiconducting moiré superlattices for quantum simulation of strongly interacting Bosons and Fermions (arXiv).

Novel control of quantum materials

- Demonstrated optical control of exciton resonances in 2D materials via exciton-carrier interactions and achieved strong optical nonlinearity for nonlinear optics and quantum optoelectronics (arXiv).
- Developed a nanoscale electromechanical device made of free-standing 2D semiconductors to manipulate the radiative lifetime of emitters using the Purcell effect (Phys. Rev. Lett.)
- Created a new type of high performance electrolyte materials for solid oxide fuel cell, utilizing the electron correlation effects to supress electronic conduction (Nature).
- Co-invented synaptic transistors for neuromorphic computing using ionic control of electron conduction in correlated oxides (Nat. Commun.).

Synthesis and fabrication of quantum materials

- Developed the fabrication of nanoscale metamaterials and their integration with materials such as 2D materials and oxides (Nat. Nanotech., Appl. Phys. Lett.).
- Devised theoretical framework and developed methods for heteroepitaxy of oxide thin films on various functional substrates (J. Cryst. Growth, J. Appl. Phys.).
- Developed electrolyte gating for modulating stoichiometry and functional properties of complex oxide thing films (Nat. Commun., J. Appl. Phys.).

Awards

2023 Selected by the US *National Academy of Engineering* as one of sixty outstanding young engineers from US and EU for the 2023 EU-US Frontiers of Engineering Symposium

2023 Outstanding Young Scientist, *Maryland Academy of Sciences*

2023 Ralph E. Powe Junior Faculty Enhancement Award, *Oak Ridge Associated Universities*

2023 Early Career Scientist Prize in the Structure and Dynamics of Condensed Matter, *International Union of Pure and Applied Physics*. Citation: For his contribution on discoveries of Wigner crystals in 2D materials and studies of their quantum phase transitions.

2022 *Department of Energy* Early Career Award

2021 *National Science Foundation* CAREER Award

2018 *Forbes* 30 Under 30–Science

2017, 19 Top Reviewer, *Applied Physics Letters*

20135 *Materials Research Society* Graduate Student Silver Award

2012 Ernst Habicht Fellowship, *Harvard University*

2005 Gold Medal, *National Physics Olympiad, China*

Publications

Total citations > 5000, *h*-index = 37, mean citation per paper > 95, according to Google Scholar.

More than 50 journal articles including *Nature* (2), *Science* (1), *Nature Nanotechnology* (3), *Nature Materials* (1), *Nature Communications* (4), *Physical Review Letters* (3), *PNAS* (1), *Nano Letters* (3), *Advanced Materials* (1), and *Proceedings of the IEEE* (1).

Selected Journal Articles (* denotes Equal Contribution)

[1] D.G. Suarez-Forero, R. Ni, S. Sarkar, M.J. Mehrabad, E. Mechtel, V. Simonyan, A. Grankin, K. Watanabe, T. Taniguchi, H. Jang, S. Park, M. Hafezi & Y. Zhou. Chiral optical nanocavity with atomically thin mirrors. arXiv:2308.04574 (2023)

[2] L. Gu, L. Zhang, R. Ni, D.S. Wild, M. Xie, S. Park, H. Jang, K. Watanabe, T. Taniguchi, M. Hafezi, & Y. Zhou. Giant optical nonlinearity of Fermi polarons in atomically thin semiconductors. arXiv:2306.11199 (2023).

[3] B. Gao, D.G. Suarez-Forero, S. Sarkar, T.S. Huang, D. Session, M.J. Mehrabad, R. Ni, M. Xie, J. Vannucci, S. Mittal, K. Watanabe, T. Taniguchi, A. Imamoglu, Y. Zhou & M. Hafezi. Excitonic Mott insulator in a Bose-Fermi-Hubbard system of moiré WS_2/WSe_2 heterobilayer. arXiv:2304.09731 (2023).

[4] Y. Zhou, J. Sung, E. Brutschea, I. Esterlis, Y. Wang, G. Scuri, R.J. Gelly, H. Heo, T. Taniguchi, K. Watanabe, M.D. Lukin, P. Kim, E. Demler & H. Park. Bilayer Wigner crystals in a transition metal dichalcogenide heterostructure. *Nature* 595, 48-52 (2021).

- News by Journal Club for Condensed Matter Physics, Quanta Magazine, MSE UMD, Harvard Gazette, Phys.org, & Chemistry World.

[5] Y. Zhou, G. Scuri, J. Sung, R.J. Gelly, D.S. Wild, K. De Greve, A.Y. Joe, T. Taniguchi, K. Watanabe, P. Kim, M.D. Lukin & H. Park. Controlling excitons in an atomically thin membrane with a mirror. *Physical Review Letter* 124, 027401 (2020). **Editors' suggestion**

[6] G. Scuri*, T.I. Andersen*, Y. Zhou*, D.S. Wild, J. Sung, R.J. Gelly, D. Berube, H. Heo, L. Shao, A.Y. Joe, A.M. Valdivia, T. Taniguchi, K. Watanabe, M. Loncar, P. Kim, M.D. Lukin & H. Park. Electrically tunable valley dynamics in twisted WSe_2/WSe_2 bilayers. *Physical Review Letter* 124, 217403 (2020).
• Highlighted by Nature Reviews Materials

[7] G. Scuri*, Y. Zhou*, A.A. High*, D.S. Wild*, C. Shu, K. De Greve, L.A. Jauregui, T. Taniguchi, K. Watanabe, P. Kim, M.D. Lukin & H. Park. Large excitonic reflectivity of monolayer $MoSe_2$ encapsulated in hexagonal boron nitride. *Physical Review Letter* 120, 037401 (2018). **Editors' suggestion**
News by Nature, APS Physics Magazine, & Chemistry World

[8] Y. Zhou*, G. Scuri*, D.S. Wild*, A.A. High*, A. Dibos, L.A. Jauregui, C. Shu, K. de Greve, K. Pistunova, A.Y. Joe, T. Taniguchi, K. Watanabe, P. Kim, M.D. Lukin & H. Park. Probing dark excitons in atomically thin semiconductors via near-field coupling to surface plasmon polaritons. *Nature Nanotechnology*, 12, 856–860 (2017).
• News and Views by Nature Nanotechnology

[9] Y. Zhou, X. Guan, H. Zhou, K. Ramadoss, S. Adam, H. Liu, S. Lee, J. Shi, M. Tsuchiya, D.D. Fong & S. Ramanathan. Strongly correlated perovskite fuel cells. *Nature* 534, 231-234 (2016).
• News by Nature Energy, Harvard University, Argonne National Laboratory, IEEE Spectrum, Phys.org, & ScienceDaily

[10] Y. Zhou & S. Ramanathan. Mott memory and neuromorphic devices. *Proceedings of the IEEE* 103, 1289 -1310 (2015). **[Invited]**

[11] J. Shi*, Y. Zhou* & S. Ramanathan. Colossal resistance switching and band gap modulation in a perovskite nickelate by electron doping. *Nature Communications* 5, 5860 (2014).
• Media Coverage by Harvard University, IEEE Spectrum, Materials Today, & NSF

Additional Journal Articles

[12] L. Zhang, R. Ni, Y. Zhou. Controlling quantum phases of electrons and excitons in moiré superlattices. *Journal of Applied Physics* 133, 080901 (2023). **[Invited, Chosen as Feature Article]**

[13] T.I. Andersen, R.J. Gelly, G. Scuri, B.L. Dwyer, D.S. Wild, R. Bekenstein, A. Sushko, J. Sung, Y. Zhou, A.A. Zibrov, A.Y. Joe, K. Watanabe, T. Taniguchi, S.F. Yelin, P. Kim, H. Park & M.D. Lukin. Beam steering at the nanosecond time scale with an atomically thin reflector. *Nature Communications* 13, 3421 (2022).

[14] A. Spitzig, A. Pivonka, H. Mickalide, A. Frenzel, J. Kim, C. Ko, Y. Zhou, K. O'Connor, E. Hudson, S. Ramanathan, J.E. Hoffman & J. Hoffman. Nanoscale thermal imaging of VO_2 via Poole-Frenkel conduction. *Applied Physics Letters* 120, 151602 (2022).

[15] A.Y. Joe, L.A. Jauregui, K. Pistunova, A.M.M. Valdivia, Z. Lu, D.S. Wild, G. Scuri, K. De Greve, R.J. Gelly, Y. Zhou, J. Sung, A. Sushko, T. Taniguchi, K. Watanabe, D. Smirnov, M.D. Lukin, H. Park & P. Kim. Electrically controlled emission from singlet and triplet exciton species in atomically thin light emitting diodes. *Physical Review B*, 103, L161411 (2021).

[16] T.I. Andersen*, G. Scuri*, A. Sushkov*, K. De Greve*, J. Sung, Y. Zhou, D.S. Wild, R.J. Gelly, H. Heo, D. Bérubé, A.Y. Joe, L.A. Jauregui, K. Watanabe, T. Taniguchi, P. Kim, H. Park & M.D. Lukin. Excitons in a reconstructed moiré potential in twisted WSe_2/WSe_2 homobilayers. *Nature Materials* 20, 480 (2021).
• Highly Cited Paper by Web of Science

[17] J. Sung, Y. Zhou, G. Scuri, V. Zolyomi, T.I. Andersen, H. Yoo, D.S. Wild, A.Y. Joe, R.J. Gelly, H. Heo, S.J. Magorrian, D. Berube, A.M. Valdivia, T. Taniguchi, K. Watanabe, M.D. Lukin, P. Kim, V.I. Falko & H. Park. Broken mirror symmetry in excitonic response of reconstructed domains in twisted $MoSe_2$/$MoSe_2$ bilayers. *Nature Nanotechnology* 15, 750-754 (2020).
• News and Views by Nature Nanotechnology

[18] L.A. Jauregui, A.Y. Joe, K. Pistunova, D.S. Wild, A.A. High, Y. Zhou, G. Scuri, K. De Greve, A. Sushko, C.H. Yu, T. Taniguchi, K. Watanabe, D.J. Needleman, M.D. Lukin, H. Park & P. Kim. Electrical control of interlayer exciton dynamics in atomically thin heterostructures. *Science* 366, 870-875 (2019).

[19] P. Roney*, A. Shahsafi*, Y. Zhou, Z. Zhang, Y. Xiao, C. Wan, R. Wambold, J. Salman, Z. Yu, J. Li, J.T. Sadowski, R. Comin, S. Ramanathan & M.A. Kats. Temperature-independent thermal radiation. *Proceedings of the National Academy of Sciences*, 116, 26402 (2019).
• News by Department of Energy & C&EN

[20] F.A. Cevallos, S. Guo, H. Heo, G. Scuri, Y. Zhou, J. Sung, T. Taniguchi, K. Watanabe, P. Kim, H. Park & R.J. Cava. Liquid salt transport growth of single crystals of the layered dichalcogenides MoS2 and WS2. *Crystal Growth & Design* 19, 5762–5767 (2019).

[21] A.M. Dibos, Y. Zhou, L.A. Jauregui, G. Scuri, D.S. Wild, A.A. High, T. Taniguchi, K. Watanabe, M.D. Lukin, P. Kim & H. Park. Electrically tunable exciton-plasmon coupling in a WSe_2 monolayer embedded in a plasmonic crystal cavity. *Nano Letters* 19, 3543 (2019).

[22] D.M. Bierman, A. Lenert, M.A. Kats, Y. Zhou, S. Zhang, M.D.L. Ossa, S. Ramanathan, F. Capasso & E.N. Wang. Radiative thermal runaway due to negative differential thermal emission. *Physical Review Applied* 10, 021001 (2018).

[23] K. Wang, K. De Greve, L.A. Jauregui, A. Sushko, A.A. High, Y. Zhou, G. Scuri, T. Taniguchi, K. Watanabe, M.D. Lukin, H. Park & P. Kim. Electrical control of charged carriers and excitons in atomically thin materials. *Nature Nanotechnology* 13, 128–132 (2018).
• News and Views by Nature Nanotechnology

[24] C. Wan, E. Horak, J. King, J. Salman, Z. Zhang, Y. Zhou, P. Roney, B. Gundlach, S. Ramanathan, R. Goldsmith & M.A. Kats. Limiting optical diodes enabled by the phase transition of vanadium dioxide. *ACS Photonics* 5, 2688–2692 (2018).

[25] J. Rensberg, Y. Zhou, S. Richter, C. Wan, S. Zhang, P. Schöppe, R. Schmidt-Grund, S. Ramanathan, F. Capasso, M.A. Kats & C. Ronning. Epsilon-near-zero substrate engineering for ultra-thin-film perfect absorbers. *Physical Review Applied* 8, 014009 (2017).

[26] Z. Zhang, F. Zuo, C. Wan, A. Datta, J. Kim, J. Rensberg , R. Nawrodt, H. Park, T. Larrabee, X. Guan, Y. Zhou, S. Prokes, C. Ronning, V. Shalaev, A. Boltasseva, M.A. Kats & S. Ramanathan. Evolution of metallicity in vanadium dioxide by creation of oxygen vacancies. *Physical Review Applied* 7, 034008 (2017).

[27] Z. Zhang, F. Zuo, C. Wan, A. Datta, J. Kim, J. Rensberg , R. Nawrodt, H. Park, T. Larrabee, X. Guan, Y. Zhou, S. Prokes, C. Ronning, V. Shalaev, A. Boltasseva, M. Kats & S. Ramanathan. Evolution of metallicity in vanadium dioxide by creation of oxygen vacancies. *Physical Review Applied* 7, 034008 (2017).

[28] K. Ramadoss, N. Mandal, X. Dai, Z. Wan, Y. Zhou, L. Rokhinson, Y. P. Chen, J. Hu & S. Ramanathan. Sign reversal of magnetoresistance in perovskite nickelates by electron doping. *Physical Review B* 94, 235124 (2016).

[29] Z. Li, Y. Zhou, H. Qi, Q. Pan, N. Shi, M. Lu, A. Stein, C.Y. Li, S. Ramanathan & N.Yu. Correlated perovskites as a new platform for super-broadband-tunable photonics. *Advanced Materials* 28, 9117-9125 (2016).

[30] J. Rensberg, S. Zhang, Y. Zhou, A.S. McLeod, C. Schwarz, M. Goldflam, M. Liu, J. Kerbusch, R. Nawrodt, S. Ramanathan, D.N. Basov, F. Capasso, C. Ronning & M.A. Kats. Active optical metasurfaces based on defect-engineered phase-transition materials. *Nano Letters* 16, 1050-1055 (2016).

[31] S. Cueff , D. Li , Y. Zhou, F. Wong , J. Kurvits , S. Ramanathan & R. Zia. Dynamic control of light emission faster than the lifetime limit using VO_2 phase-change. *Nature Communications* 6, 8636 (2015).

[32] J. Chen*, Y. Zhou*, S. Middey, J. Jiang, N. Chen, L. Chen, X. Shi, M. Döbeli, J. Shi, J. Chakhalian & S. Ramanathan. Self-limited kinetics of electron doping in correlated oxides. *Applied Physics Letters* 107, 031905 (2015). (* Equally contributing authors)

[33] S. Savo, Y. Zhou, G. Castaldi, M. Moccia, V. Galdi, S. Ramanathan & Y. Sato. Reconfigurable anisotropy and functional transformations with VO_2-based metamaterial electric circuits. *Physical Review B* 91, 134105 (2015).

[34] Y. Zhou*, J. Park*, J. Shi, M. Chhowalla, H. Park, D.A. Weitz & S. Ramanathan. Control of emergent properties at a correlated oxide interface with graphene. *Nano Letters* 15, 1627-1634 (2015). (* Equally contributing authors)

[35] S. Zhang, M.A. Kats, Y. Cui, Y. Zhou, Y. Yao, S. Ramanathan & F. Capasso. Current-modulated optical properties of vanadium dioxide thin films in the phase transition region. *Applied Physics Letters* 105, 211104 (2014).

[36] H.N. Krishnamoorthy, Y. Zhou, S. Ramanathan, E. Narimanov & V.M. Menon. Tunable hyperbolic metamaterials utilizing phase change heterostructures. *Applied Physics Letters* 104, 121101 (2014).

[37] S.D. Ha, Y. Zhou, C.J. Fisher, S. Ramanathan & J.P. Treadway. Abrupt insertion loss drop by RF-triggering of the phase transition in CPW switches. *Microwave and Wireless Components Letters, IEEE* 24, 575 (2014).

[38] S. D. Ha, Y. Zhou, Duwel, A. E., White, D. W. & S. Ramanathan Quick Switch: Strongly correlated electronic phase transition systems for cutting-edge microwave devices. *Microwave Magazine, IEEE* 15, 32-44 (2014).

[39] S.D. Ha, Y. Zhou, C.J. Fisher, S. Ramanathan & J.P. Treadway. Electrical switching dynamics and broadband microwave characteristics of VO_2 radio frequency devices. *Journal of Applied Physics* 113, 184501 (2013).

[40] J. Shi, S.D. Ha, Y. Zhou, F. Schoofs & S. Ramanathan. A correlated nickelate synaptic transistor. *Nature Communications* 4, 2676 (2013).
• Media Coverage by Harvard University, Materials Today, MRS, New Atlas, & Phys.org

[41] Y. Zhou & S. Ramanathan. GaN/VO_2 heteroepitaxial pn junctions: Band offset and minority carrier dynamics. *Journal of Applied Physics* 113, 213703 (2013).

[42] Y. Zhou & S. Ramanathan. Correlated electron materials and field-effect transistors for Logic: A review. *Critical Reviews in Solid State and Materials Sciences* 38, 286-317 (2013).

[43] Y. Zhou, X. Chen, C. Ko, Z. Yang, C. Mouli & S. Ramanathan. Voltage-triggered ultrafast phase transition in vanadium dioxide switches. *Electron Device Letters, IEEE* 34, 220-222 (2013).
• Highly Cited Paper by Web of Science

[44] J.S. Sim, Y. Zhou & S. Ramanathan. Suspended sub-50 nm vanadium dioxide membrane transistors: fabrication and ionic liquid gating studies. *Nanoscale* 4, 7056 (2012).

[45] Y. Zhou & S. Ramanathan. Relaxation dynamics of ionic liquid — VO_2 interfaces and influence in electric double-layer transistors. *Journal of Applied Physics* 111, 084508 (2012).

[46] Z. Yang, Y. Zhou & S. Ramanathan. Studies on room-temperature electric-field effect in ionic-liquid gated VO_2 three-terminal devices. *Journal of Applied Physics* 111, 014506 (2012).

[47] Y. Zhou & S. Ramanathan. Heteroepitaxial VO_2 thin films on GaN: Structure and metal-insulator transition characteristics. *Journal of Applied Physics* 112, 074114 (2012).

[48] F.J. Wong, Y. Zhou & S. Ramanathan. Epitaxial variants of VO_2 thin films on complex oxide single crystal substrates with $3m$ surface symmetry. *Journal of Crystal Growth* 364, 74 (2012).

[49] Y. Zhou, Z. Yang & S. Ramanathan. Multi-resistance states through electrically driven phase transitions in $VO_2/HfO_2/VO_2$ heterostructures on silicon. *Electron Device Letters, IEEE* 33, 101-103 (2012).

[50] C. Ko, Y. Zhou & S. Ramanathan. Probing compositional disorder in vanadium oxide thin films grown on atomic layer deposited hafnia on silicon by capacitance spectroscopy. *Journal of Vacuum Science & Technology A* 30, 011501 (2012).

[51] Y. Cui, X. Wang, Y. Zhou, R. Gordon & S. Ramanathan. Synthesis of vanadium dioxide thin films on conducting oxides and metal-insulator transition characteristics. *Journal of Crystal Growth* 338, 96 (2011).

Book Chapters

[1] Y. Zhou, S. D. Ha & S. Ramanathan. Computation and learning with metal-insulator transitions and emergent phases in correlated oxides. in T.-J. K. Liu & K. Kuhn (Eds.), CMOS and Beyond: Logic Switches for Terascale Integrated Circuits(Cambridge University Press, Cambridge, UK; New York, USA, 2015).

[2] S. D. Ha, Y. Zhou, R. Jaramillo & S. Ramanathan. Correlated electrons: A platform for solid state devices. in S. Luryi, J. Xu & A. Zaslavsky (Eds.), Future Trends in Microelectronics: Frontiers and Innovations(John Wiley & Sons, Inc. Hoboken, NJ, USA, 2013).

Invention Disclosures and Patents

2023 *Nonlinear optical devices based on van der Waals semiconductors*, Y. Zhou & L. Gu, Patent Application Filed.

2016 *Electrochemical systems based on charge induced electron localization*, Y. Zhou & S. Ramanathan, Patent Application Filed.

2015 *Dopant-driven phase transitions in correlated metal oxides*, J.Shi, Y. Zhou & S. Ramanathan, US 10,600,959, Patent Granted.

2014 *Electrically-driven phase transitions in functional oxide heterostructures*, Y. Zhou, Z. Yang & S. Ramanathan, US 9,343,206, Patent Granted.

Synergistic Activities

Professional Service

2021- **Proposal Reviewer**, Department of Energy, National Science Foundation.

2020- **Midterm Funding Reviewer**, Department of Energy.

2022- **Panelist**, NSF Graduate Research Fellowship Program (GRFP).

2013-present **Journal Referee** for more than 30 journals, including *Nature*, *Nature Communications*, *Nature Materials*, *Nature Reviews Materials*, *Physical Review Letters*, *Physical Review X*. *2D Materials*, ACS Applied Materials & Interfaces, ACS Photonics, *Advanced Materials*, *Applied Physics Letters*, *APL Materials*, *Applied Optics*, *Electrochemistry Communications*, *IEEE Electron Device Letters*, *IEEE Transactions on Electron Devices*, *Journal of Applied Physics*, *Journal of the Optical Society of America B*, *Materials Today*, *Materials Today Chemistry*, *Materials Today Physics*, *Nano Letters*, *Nanoscale*,*Optica*, *Optical Materials Express*, *Optics Express*, *Optics Letters*, *Physical Review Applied*, *Physical Review B*, *Physical Review Materials*, *Physical Review Research*, and *Scientific Reports*

2020 **Organizer**, Symposium on Correlated Insulating States in Two Dimensions, Harvard University, Youtube Recordings.

2017- **Session Chair**, **2023**: APS March Meeting *Focus Session 12.01.02 2D Materials: Multi-layer Moiré and Functionalities*; **2017**: MRS Fall Meeting *Symposium EM09.01: Solid-Liquid Devices I*.

Outreach

2023 **Speaker**, Pre-College Scholars Program, Summer Camp, UMD.

2023 **Mentor**, Asian American Academy of Science and Engineering (AAASE Mentorship) Program.

2023 **Speaker**, Engineering Seminar at Howard Community College.

2021- **Advisor** of three high-school research interns for Maryland Public Schools.

2021-23 **Host** of six summer students for *Summer RISE Program*, Montgomery County Public Schools.

2021 **Mentor** of low-income first-gen students, *Forbes 30 Under 30 x Close the Gap Foundation*.

Department and University Service

2023 **Member**, Performance Review Committee, Department of Materials Science and Engineering, University of Maryland.

2023 **Discussant**, DOE Career Proposal Town Hall, University of Maryland.

2022- **Member**, University Quantum Science and Technology Minor, University of Maryland.

2022- **Member**, Diversity, Equity, and Inclusion (DEI) Committee, Department of Materials Science and Engineering, University of Maryland.

2023 **Member**, Graduate Admission Committee, Department of Materials Science and Engineering, University of Maryland.

2022 **Panelist**, ENGR CAREER Proposal Town Hall, A. James Clark School of Engineering, University of Maryland.

2021, 22 **Panelist**, *Future Faculty Program*, A. James Clark School of Engineering, University of Maryland.

Memberships

American Physical Society

Institute of Electrical and Electronics Engineers

Materials Research Society