JIE XU, PhD

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EDUCATION AND RELEVANT EXPERIENCE

Argonne National Lab, Lemont, IL, USA — Oct. 2018 – present
Staff Scientist, Nanoscience and Technology

Stanford University, Stanford, CA, USA — Dec. 2014 – Aug.2018
Postdoctoral Scholar, Chemical Engineering — *Advisor: Prof. Zhenan Bao*

Nanjing University, Nanjing, China — Sept 2009 – Jun 2014
Ph. D., Chemistry and Chemical Engineering — *Advisor: Prof. Gi Xue*
Major: Polymer Chemistry and Physics

University of Michigan, Ann Arbor, MI — Mar 2013 – Apr 2013
Visiting student, Chemistry — *Advisor: Prof. Zhan Chen*

Stanford University, Stanford, CA, USA — Jan 2012 – Apr 2012
Visiting student, Chemical Engineering — *Advisor: Prof. Zhenan Bao*

Nanjing University, Nanjing, China — Sept 2005 – Jun 2009
B.S., Chemistry and Chemical Engineering,
Major: Chemistry; Minor: Polymer Chemistry and Physics

RESEARCH EXPERIENCE

Stanford University — Dec. 2014 – Aug. 2018
Postdoc fellow
Supervisor: Prof. Zhenan Bao

Stretchable Polymer Semiconductors:

- Developed highly stretchable polymer semiconductor films through nanoconfinement effect;
- Developed highly stretchable polymer semiconductor films through modulating molecular packing;
- Developed intrinsically stretchable transistor with no change in mobility up to 100% strain.

Large-Area Advanced Solution Printing of Aligned Stretchable Polymer Semiconductor Films:

- Achieved roll-to-roll coating of a stretchable polymer semiconductor blend with a high degree of alignment of the polymer semiconductor nanostructure;
- Achieved an unprecedented charge mobility of 8 $cm^2 V^{-1} s^{-1}$ in five different printed stretchable semiconducting film;
- Revealed the relationships between molecular packing structures and mechanical/electrical behaviors in electronic materials.

Skin-Like Electronics Based on Intrinsically Stretchable Transistor Arrays:

- Developed intrinsically stretchable transistor arrays using stretchable polymer semiconductor, dielectrics and conductors;
- Developed intrinsically stretchable functional circuits.

Nanjing University — Sept 2009 – Jun 2014

Graduate Research Assistant
Supervisor: Prof. Gi Xue

"Cold" Fabrication Process for Polymers:

- Developed a novel low-temperature fabrication method for polymeric materials through the combination of nanoconfinement- and the stress-enhanced dynamic mobility;
- Expanded the manufacturing methodology and the applications of polymeric materials, especially for bioactive composites, where conventional high-temperature processing is not applicable.

Peculiar Behavior of Polymers Confined at Nanoscale Films:

- Explored the geometrical size effect on the conformation and physical properties of polymer chains;
- Explored the effect of interfacial interaction on the conformation and physical properties of polymer chains.

University of Michigan Mar 2013 – Apr 2013
Visiting student
Supervisor: Prof. Zhan Chen, Prof. Gi Xue

Different Chain Configurations in Confined Thin Polymer Films with Controlled Interface:

- Utilized the sum frequency generation spectroscopy (SFG) to analyze the polymer chain configurations at surfaces and interfaces on modified substrate.

Stanford University Jan 2012 – Apr 2012
Visiting student
Supervisor: Prof. Zhenan Bao, Prof. Gi Xue

Aligned Non-Equilibrium Single-Crystalline Organic Small Molecules Semiconducting Film Fabrication:

- Developed an approach – termed fluid-enhanced crystal engineering – for solution printing organic thin films with large single-crystalline domains;
- Fabricated thin film of 6,13-bis(triisopropylsilylethynyl) pentacene having the non-equilibrium packing structure under nanoconfinement, which gave a record high average and maximum mobilities.

AWARDS & HONORS

Materials Research Society (MRS) Postdoctoral Award (only two per meeting), 2018 spring, USA
5th annual Stanford Polymer Collective (SPC) poster symposium - 1st Place, USA, 2017

PUBLICATIONS

1) **Xu, J.**; Ehrlich, A.; Zhu, C; Shaw L.; Wang, G.-J. N.; Katsumata T.; Wang, S.; Wu, H. –C.; Gu, X.; Lopez, F. M.; Bao, Z., Large-Area Solution Coating of Stretchable Polymer Semiconductor Films with Aligned Nanoconfined Morphology. Under revision.
2) **Xu, J.**; Wu, H. -C.; Mun, J.; Ning, R.; Wang, G.-J. N.; Gu, X.; Bao, Z., Improving the ductility of semiconducting polymer through reducing the interchain coupling. In preparation.
3) Wang, G.-J. N.; Molina-Lopez, F.; Zhang, H.; **Xu, J.;** Wu, H.-C.; Lopez, J.; Shaw, L.; Mun, J.; Zhang, Q.; Wang, S.; Ehrlich, A.; Bao, Z., Nonhalogenated Solvent Processable and Printable High-Performance

Polymer Semiconductor Enabled by Isomeric Nonconjugated Flexible Linkers. **Macromolecules 2018**, 51 (13), 4976-4985.

4) Lopez, F. M.; Wu, H. -C.; Wang, G.-J. N.; Yan, H.; Shaw L.; **Xu, J.**; Toney, M. F. and Bao, Z., Enhancing Molecular Alignment and Charge Transport of Solution-Sheared Semiconducting Polymer Films by the Electrical-Blade Effect. **Advanced Electronic Materials**, 1800110.
5) Wang, S.*; Oh, J. Y.*; **Xu J.*** (* contribute equally)**;** Tran, H.; Bao, Z., Skin-Electronics: An Emerging Paradigm, **Accounts of Chemical Research** 2018, 51, 1033-1045
6) Wang, S. *; **Xu J.***(* contribute equally); Wang, W. C.; Wang, G. J. N.; Rastak, R.; Molina-Lopez, F.; Chung, J. W.; Niu, S. M.; Feig, V. R.; Lopez, J.; Lei, T.; Kwon, S. K.; Kim, Y.; Foudeh, A. M.; Ehrlich, A.; Gasperini, A.; Yun, Y.; Murmann, B.; Tok, J. B. H.; Bao, Z., Skin electronics from scalable fabrication of an intrinsically stretchable transistor array. **Nature** 2018, 555, 83

   **Featured by xinhuanews: "U.S. Stanford researchers unveil significant advancement in skin electronics Staying conductive in the stretch".

   **Featured by Stanford news: "Stanford researchers develop stretchable, touch-sensitive electronics" https://news.stanford.edu/2018/02/19/stretchable-touch-sensitive-electronics/

   **Featured by TechXplore: "Researchers develop stretchable, touch-sensitive electronics"
7) **Xu, J.***; Wang, S.* (* contribute equally); Wang, G. J. N.; Zhu, C. X.; Luo, S. C.; Jin, L. H.; Gu, X. D.; Chen, S. C.; Feig, V. R.; To, J. W. F.; Rondeau-Gagne, S.; Park, J.; Schroeder, B. C.; Lu, C.; Oh, J. Y.; Wang, Y. M.; Kim, Y. H.; Yan, H.; Sinclair, R.; Zhou, D. S.; Xue, G.; Murmann, B.; Linder, C.; Cai, W.; Tok, J. B. H.; Chung, J. W.; Bao, Z., Highly stretchable polymer semiconductor films through the nanoconfinement effect. **Science** 2017, 355(6320): 59-64.

   **Featured by Science: "Staying conductive in the stretch" 355 (2017) 24-25.

   **Featured by Nature Nanotechnology: "Wearable electronics: Stretching the limits" 12 (2017) 101.

   **Featured by Clinical Chemistry "Electronics that flex themselves" 63 (2017) 1308-1310.

   **Featured by Physics Today "Polymer-based transistors bring fully stretchable devices within reach" 70, (2017) 14-16.

   **Highlighted in Physics World: "Stretchable transistor could be a second skin";

   **Highlighted in C&EN: "Super stretchy semiconducting polymers";

   **Highlighted on Phys. org: "A transistor that can be stretched to twice its length with minimal loss of conductivity";

   **Highlighted on ScienceDaily: "A flexible transistor that conforms to skin";

   **Highlighted in ECN, News Atlas, New Scientist, Steemit, CCT News, EurekAlert, Printed Electronics World, etc
8) Lu, C.; Lee, W. Y.; Gu, X. D.; **Xu, J.**; Chou, H. H.; Yan, H. P.; Chiu, Y. C.; He, M. Q.; Matthews, J. R.; Niu, W. J.; Tok, J. B. H.; Toney, M. F.; Chen, W. C.; Bao, Z., Effects of Molecular Structure and Packing Order on the Stretchability of Semicrystalline Conjugated Poly(Tetrathienoacene-diketopyrrolopyrrole) Polymers. **Advanced Electronic Materials** 2017, 3 (2).
9) Wang, G. J. N.; Shaw, L.; **Xu, J.**; Kurosawa, T.; Schroeder, B. C.; Oh, J. Y.; Benight, S. J.; Bao, Z., Inducing Elasticity through Oligo-Siloxane Crosslinks for Intrinsically Stretchable Semiconducting Polymers. **Advanced Functional Materials** 2016, 26 (40), 7254-7262.
10) Schroeder, B. C.; Chiu, Y. C.; Gu, X. D.; Zhou, Y.; **Xu, J.;** Lopez, J.; Lu, C.; Toney, M. F.; Bao, Z., Non-Conjugated Flexible Linkers in Semiconducting Polymers: A Pathway to Improved Processability

without Compromising Device Performance. **Advanced Electronic Materials** 2016, 2 (7).

11) Rao, Y. L.; Chortos, A.; Pfattner, R.; Lissel, F.; Chiu, Y. C.; Feig, V.; **Xu, J.;** Kurosawa, T.; Gu, X. D.; Wang, C.; He, M. Q.; Chung, J. W.; Bao, Z. N. Stretchable Self-Healing Polymeric Dielectrics Cross-Linked Through Metal-Ligand Coordination. **Journal of the American Chemical Society** 2016, 138 (18), 6020-6027.
12) Park, S.; Lee, M. H.; Ahn, K. S.; Choi, H. H.; Shin, J.; **Xu, J**.; Mei, J. G.; Cho, K.; Bao, Z. A.; Lee, D. R.; Kang, M. S.; Kim, D. H. Combinatorial Study of Temperature-Dependent Nanostructure and Electrical Conduction of Polymer Semiconductors: Even Bimodal Orientation Can Enhance 3D Charge Transport. **Advanced Functional Materials** 2016, 26 (26), 4627-4634.
13) Oh, J. Y.; Rondeau-Gagne, S.; Chiu, Y. C.; Chortos, A.; Lissel, F.; Wang, G. J. N.; Schroeder, B. C.; Kurosawa, T.; Lopez, J.; Katsumata, T.; **Xu J.**, Zhu, C. X.; Gu, X. D.; Bae, W. G.; Kim, Y.; Jin, L. H.; Chung, J. W.; Tok, J. B. H.; Bao, Z. N. Intrinsically stretchable and healable semiconducting polymer for organic transistors. **Nature** 2016, 539 (7629), 411-415.
14) Li X.*; **Xu J.***(* contribute equally); Wang, D.; Sha, Y.; Chen, W.; Zhou, D. S.; Wang, X. L.; Sun, Q.; Xue, G.; Li, L. L., Low-temperature processing of polymer nanoparticles for bioactive composites. **Journal of Polymer Science Part B: Polymer Physics** 2016, 54(24): 2514-2520.
15) Giri, G.; DeLongchamp, D. M.; Reinspach, J.; Fischer, D. A.; Richter, L. J.; **Xu, J.**; Benight, S.; Ayzner, A.; He, M. Q.; Fang, L.; Xue, G.; Toney, M. F.; Bao, Z. N. Effect of Solution Shearing Method on Packing and Disorder of Organic Semiconductor Polymers. **Chemistry of Materials** 2015, 27 (7), 2350-2359.
16) **Xu J.;** Ding L.; Chen J; Gao S; Li L.L.; Zhou D.; Li X.; Xue G., Sensitive characterization of the influence of substrate interfaces on supported thin films. **Macromolecules** 2014, 47(18): 6365-6372.
17) **Xu J.*;** Diao Y.* (* contribute equally); Zhou, D. S.; Mao, Y. S.; Giri, G.; Chen, W.; Liu, N.; Mannsfeld, S. C. B.; Xue, G.; Bao, Z., Probing the interfacial molecular packing in TIPS-pentacene organic semiconductors by surface enhanced Raman scattering. **Journal of Materials Chemistry C** 2014, 2(16): 2985-2991.
18) Diao, Y.; Lenn, K. M.; Lee, W. Y.; Blood-Forsythe, M. A.; **Xu, J.**; Mao, Y. S.; Kim, Y.; Reinspach, J. A.; Park, S.; Aspuru-Guzik, A.; Xue, G.; Clancy, P.; Bao, Z., Understanding polymorphism in organic semiconductor thin films through nanoconfinement. **Journal of the American Chemical Society** 2014, 136 (49), 17046-17057.
19) Chen, J.; Li, L.; Zhou, D.; **Xu, J.**; Xue, G., Effect of molecular chain architecture on dynamics of polymer thin films measured by the ac-chip calorimeter. **Macromolecules** 2014, 47 (10), 3497-3501.
20) Diao, Y.; Tee, B. C. K.; Giri, G.; **Xu, J.**; Kim, D. H.; Becerril, H. A.; Stoltenberg, R. M.; Lee, T. H.; Xue, G.; Mannsfeld, S. C. B.; Bao, Z., Solution coating of large-area organic semiconductor thin films with aligned single-crystalline domains. **Nature materials** 2013, 12 (7), 665.

    **Selected as the front cover of Nature Materials

    **Featured in Nature Materials News and Views. doi:10.1038/nmat3686
    "Organic semiconductors: Made to order" 6/2/2013

    **Featured in SLAC/Stanford news, ScienceDaily, R&D Magazine, EurekAlert, Materials today, the Engineer etc. "Printing Innovations Provide 10-fold Improvement in Organic Electronics"6/3/2013

    **Featured by Materials Research Society in Materials306. "Fluid-Enhanced Crystal Engineering Improves Upon Solution Coating of Organic Semiconductors" 6/3/2013

    **Featured in Nanotechweb. "Solution coating the easy way" 6/26/2013

21) Chen, J.; **Xu, J.**; Wang, X.; Zhou, D.; Sun, P.; Xue, G., Thickness Dependence of Glass Transitions Measured by AC-Chip Calorimetry in Films with Controlled Interface. **Macromolecules** 2013, 46 (17), 7006-7011.
22) Shen, J.; Jiang, W.; Liu, Y.; Wei, R.; Liu, X.; Zhong, Y.; **Xu, J.**; Li, L.; Xue, G., Synthesis and thermal properties of poly (methyl methacrylate)-poly (L-lactic acid)-poly (methyl methacrylate) tri-block copolymer. **Journal of Applied Polymer Science** 2012, 124 (5), 3905-3911.
23) **Xu J.**; Li D.; Chen J.; Din L.; Wang X.; Tao F.; Xue G., Detection of interchain proximity and segmental motion of polymer glass. **Macromolecules** 2011, 44(18): 7445-7450.

SCHOLARLY PRESENTATIONS

1) "Large-Area Solution Coating of Stretchable Polymer Semiconductor Films with Aligned Nanoconfined Morphology", oral presentation, 2017 MRS fall meeting, Boston, MA, USA, Nov. 26-Dec 1, 2017
2) "Highly Stretchable Polymer Semiconductor Films through the Nanoconfinement Effect", oral presentation, 2017 ACS National Meeting Spring, San Francisco, CA, USA, Apr. 2-6, 2017
3) "Confinement for Thin Film on Substrates with Different Geometric Curvatures", oral presentation, 2014 APS March Meeting, Denver, Colorado, USA, Mar. 3-7, 2014
4) "Probe of Dynamic Heterogeneity in Freeze-dried Polymer", poster presentation, 7th International Discussion Meeting on Relaxations in Complex systems, Barcelona, Spain, July 21-26, 2013
5) "Probe of Dynamic Heterogeneity in Freeze-dried Polymer with Similarities to Thin Film" oral presentation, 2013 APS March Meeting, Baltimore, Maryland, USA, Mar. 18-22, 2013
6) "Inter- and Intra-Chain Proximity in PS and PMMA Free-Standing Thin Films Studied by Fluorescence NRET", oral presentation, 2012 APS March Meeting, Boston, MA, USA, Feb. 27 – Mar. 2, 2012
7) "Interchain Coupling in Thin Polymer Film Studied by Fluorescence Nonradiative Energy Transfer", oral presentation, 2011 APS March Meeting, Dallas, TX, USA, March 21-25, 2011

PATENTS

1) **Xu J.,** Chung J., Bao Z., "Stretchable Organic Semiconductor by Blending Method." U.S. Non-provisional Application. Atty. Dkt. No. 15639-000302-US-01, filed April 2017
2) **Xu J.,** Yun Y., Bao Z., "Improving the ductility of semiconducting polymer through reducing the interchain coupling." U.S. Non-provisional Application. (pending)
3) Xue G., Li X., Wang X., Zhou D., **Xu J.,** Teng C., Li L., "Preparation method of bioactive molecule and macromolecule composite material", publication number CN 105385057, published March 2016

TEACHING AND MENTORING

2014-Present Graduate Research Mentor, Chemical Engnieering, **Stanford University**
- Ehrlich Anatol, visiting master's student from ETH Zürich
- Rui Ning, master's student, Stanford University
- Weichen Wang, graduate student, Stanford University

2009-2014 Graduate Research Mentor, Chemistry and Chemical Engineering, **Nanjing University**
- Xiang Li, doctoral student
- Jiao Cheng, doctoral student
- Lei Ding, doctoral student

2010 Teaching Assistant, Analytical chemical projects laboratory, **Nanjing University**

- Training the equipment of FTIR, GC-MS, UV-vis spectroscopy, Fluorescent spectroscopy, DSC, TGA
- Co-teaching the analysis of the spectrums.

REVIEWER

Nature Communications, Chemistry of Materials, etc.

LEADERSHIP

Stanford eWear Student Society, Co-organizer of eWear student symposium 2017