

# Stanford

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## Yan Xia

Associate Professor of Chemistry

### CONTACT INFORMATION

- **Administrative Contact**

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### Bio

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#### BIO

Designing and synthesizing exotic small and giant molecules for unusual properties, Associate Professor Yan Xia works at the interface of chemistry and materials science. His research combines catalysis, organic and polymer chemistry, and a range of advanced characterizations to create, control, and study novel (macro)molecular structures and organic materials with tailored conformations, nanostructures, properties, and functions. These new soft materials have interesting and unusual properties/functions for applications in energy-efficient molecular separations, sustainable plastics, electronics, and therapeutics.

Prof. Xia studied chemistry at Peking University (B.S. 2002), McMaster University (M.S. 2005), and Caltech (Ph.D. 2010). Following his PhD, he worked at Dow Chemical and MIT before joining the chemistry faculty at Stanford in the summer of 2013. His longstanding research interest is to develop novel organic materials at the interface of chemistry and materials science.

Research in the Xia Group combines vigorous function-driven syntheses, rational molecular design, and in-depth understanding of (macro)molecular reactivity, property, and function. Powerful synthetic methods are the enabling force behind their development of novel organic materials. They have developed various types of chemistry to generate diverse molecular ladder materials with high microporosity, antiaromaticity, or responsive behaviors; polymers with controlled microstructures and degradation; dynamic polymer networks and hydrogels.

#### ACADEMIC APPOINTMENTS

- Associate Professor, Chemistry
- Member, Bio-X

#### HONORS AND AWARDS

- Sloan Research Fellowship, Alfred P. Sloan Foundation (2019)
- Cottrell Scholar Award, Research Corporation for Science Advancement (2017)
- Thieme Chemistry Journals Award, Thieme Chemistry (2017)
- CAREER Award, National Science Foundation (2016)
- 3M Non-Tenured Faculty Award, 3M (2016)

- Terman Fellowship, Stanford (2014-16)
- Army Research Office Young Investigator Award, U.S. Army Research Laboratory, Army Research Office (2015)

## PROFESSIONAL EDUCATION

- PhD, California Institute of Technology , Chemistry (2010)
- MS, McMaster University , Chemistry (2005)
- BS, Peking University , Chemistry (2002)

## LINKS

- Xia Group: <http://xialab.stanford.edu/>

## Research & Scholarship

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### CURRENT RESEARCH AND SCHOLARLY INTERESTS

Projects at the interface of synthetic chemistry and materials science include:

1. Microporous polymer membranes for gas separations
2. Stress-responsive polymers
3. Degradable/Depolymerizable polymers and plastic upcycling
4. Dynamic polymer networks and hydrogels
5. Unusual conjugated pi-systems as optoelectronic materials
6. Polyelectrolyte complexes

## Teaching

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### COURSES

#### 2021-22

- Advanced Organic Chemistry II: CHEM 223 (Win)
- Organic Chemistry Laboratory: CHEM 124 (Aut)

#### 2020-21

- Advanced Organic Chemistry I: CHEM 221 (Aut)

#### 2019-20

- Advanced Organic Chemistry II: CHEM 223 (Win)
- Creativity in Organic Chemistry: CHEM 233C (Spr)
- Organic Chemistry Laboratory: CHEM 124 (Aut)

#### 2018-19

- Creativity in Organic Chemistry: CHEM 233A (Aut)
- Creativity in Organic Chemistry: CHEM 233B (Spr)
- Creativity in Organic Chemistry: CHEM 233C (Spr)
- Design and Synthesis of Polymers: CHEM 137 (Win)
- Organic Chemistry Seminar Presentation: CHEM 231 (Aut, Win, Spr)

### STANFORD ADVISEES

Doctoral Dissertation Reader (AC)

Caleb Jadrich, Sarah Jones, Yung-Hao Lin, Pournima Narayanan, Vince Pane, Sajan Patel, Makenna Pennel, Yu Zheng

#### Postdoctoral Faculty Sponsor

Dylan Freas, Dan Lee

#### Doctoral Dissertation Advisor (AC)

Kayla Barker, J.D. Feist, Erica Flear, Matias Horst, Amy Laturski, Ashley Robinson, Francesca Starvaggi, Jinghui Yang, Zekun Ye, KE ZHENG

## Publications

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### PUBLICATIONS

- **Hydrocarbon ladder polymers with ultrahigh permselectivity for membrane gas separations.** *Science (New York, N.Y.)*  
Lai, H. W., Benedetti, F. M., Ahn, J. M., Robinson, A. M., Wang, Y., Pinnau, I., Smith, Z. P., Xia, Y.  
2022; 375 (6587): 1390-1392
- **A versatile approach for the synthesis of degradable polymers via controlled ring-opening metathesis copolymerization.** *Nature chemistry*  
Feist, J. D., Lee, D. C., Xia, Y.  
2021
- **Predictably Engineering the Viscoelastic Behavior of Dynamic Hydrogels via Correlation with Molecular Parameters.** *Advanced materials (Deerfield Beach, Fla.)*  
Lou, J., Friedowitz, S., Will, K., Qin, J., Xia, Y.  
2021: e2104460
- **Understanding the Mechanochemistry of Ladder-Type Cyclobutane Mechanophores by Single Molecule Force Spectroscopy.** *Journal of the American Chemical Society*  
Horst, M., Yang, J., Meisner, J., Kouznetsova, T. B., Martinez, T. J., Craig, S. L., Xia, Y.  
2021
- **Bicyclohexene-peri-naphthalenes: Scalable Synthesis, Diverse Functionalization, Efficient Polymerization, and Facile Mechanoactivation of Their Polymers.** *Journal of the American Chemical Society*  
Yang, J., Horst, M., Werby, S. H., Cegelski, L., Burns, N. Z., Xia, Y.  
2020; 142 (34): 14619–26
- **Enol Ethers Are Effective Monomers for Ring-Opening Metathesis Polymerization: Synthesis of Degradable and Depolymerizable Poly(2,3-dihydrofuran).** *Journal of the American Chemical Society*  
Feist, J. D., Xia, Y.  
2020
- **Tunable Coacervation of Well-Defined Homologous Polyanions and Polycations by Local Polarity** *ACS CENTRAL SCIENCE*  
Lou, J., Friedowitz, S., Qin, J., Xia, Y.  
2019; 5 (3): 549–57
- **Dynamic Hyaluronan Hydrogels with Temporally Modulated High Injectability and Stability Using a Biocompatible Catalyst.** *Advanced materials (Deerfield Beach, Fla.)*  
Lou, J., Liu, F., Lindsay, C. D., Chaudhuri, O., Heilshorn, S. C., Xia, Y.  
2018; 30 (22): e1705215
- **Mechanochemical unzipping of insulating poly(ladderene) to semiconducting polyacetylene** *Science*  
Chen, Z., Mercer, J. A., Zhu, X., Romaniuk, J. A., Pfattner, R., Cegelski, L., Martinez, T. J., Burns, N. Z., Xia, Y.  
2017; 357 (6350): 475-479
- **Regioselective Synthesis of [3]Naphthylenes and Tuning of Their Antiaromaticity.** *Journal of the American Chemical Society*  
Jin, Z. n., Teo, Y. C., Teat, S. J., Xia, Y. n.  
2017; 139 (44): 15933–39
- **Efficient Synthesis of Rigid Ladder Polymers via Palladium Catalyzed Annulation.** *Journal of the American Chemical Society*  
Liu, S., Jin, Z., Teo, Y. C., Xia, Y.

2014; 136 (50): 17434-17437

- **Catalytic arene-norbornene annulation (CANAL) ladder polymer derived carbon membranes with unparalleled hydrogen/carbon dioxide size-sieving capability** *JOURNAL OF MEMBRANE SCIENCE*  
Hazazi, K., Wang, Y., Bettahalli, N., Ma, X., Xia, Y., Pinnau, I.  
2022; 654
- **Synthesis of Contorted Polycyclic Conjugated Hydrocarbons via Regioselective Activation of Cyclobutadienoids.** *Journal of the American Chemical Society*  
Yin, X., Zheng, K., Jin, Z., Horst, M., Xia, Y.  
2022
- **Effect of Fluoroalkylsilane Surface Functionalization on Boron Combustion.** *ACS applied materials & interfaces*  
Baek, J., Jiang, Y., Demko, A. R., Jimenez-Thomas, A. R., Vallez, L., Ka, D., Xia, Y., Zheng, X.  
2022
- **Comparative experimental and computational study of synthetic and natural bottlebrush polyelectrolyte solutions.** *The Journal of chemical physics*  
Horkay, F., Chremos, A., Douglas, J. F., Jones, R., Lou, J., Xia, Y.  
2021; 155 (7): 074901
- **Looping-in complexation and ion partitioning in nonstoichiometric polyelectrolyte mixtures.** *Science advances*  
Friedowitz, S., Lou, J., Barker, K. P., Will, K., Xia, Y., Qin, J.  
2021; 7 (31)
- **Enhancing Mechanical and Combustion Performance of Boron/Polymer Composites via Boron Particle Functionalization.** *ACS applied materials & interfaces*  
Jiang, Y., Dincer Yilmaz, N. E., Barker, K. P., Baek, J., Xia, Y., Zheng, X.  
2021
- **Mechanochemical generation of acid-degradable poly(enol ether)s** *CHEMICAL SCIENCE*  
Yang, J., Xia, Y.  
2021; 12 (12): 4389-94
- **Engineered Matrices Enable the Culture of Human Patient-Derived Intestinal Organoids** *ADVANCED SCIENCE*  
Hunt, D. R., Klett, K. C., Mascharak, S., Wang, H. Y., Gong, D., Lou, J., Li, X., Cai, P. C., Suhar, R. A., Co, J. Y., LeSavage, B. L., Foster, A. A., Guan, et al  
2021
- **Polymerization of Cyclopropenes: Taming the Strain for the Synthesis of Controlled and Sequence-Regulated Polymers.** *Accounts of chemical research*  
Elling, B. R., Su, J. K., Xia, Y.  
2020
- **Mechanochemical synthesis of an elusive fluorinated polyacetylene.** *Nature chemistry*  
Boswell, B. R., Mansson, C. M., Cox, J. M., Jin, Z., Romaniuk, J. A., Lindquist, K. P., Cegelski, L., Xia, Y., Lopez, S. A., Burns, N. Z.  
2020
- **Ring-Opening Metathesis Polymerization of 1,1-Disubstituted 1-Methylcyclopropenes** *MACROMOLECULES*  
Su, J. K., Lee, S., Elling, B. R., Xia, Y.  
2020; 53 (14): 5833-38
- **Catalytic Arene (oxa)Norbornene Annulation (CANAL)** *TRENDS IN CHEMISTRY*  
Leibham, A. M., Xia, Y.  
2020; 2 (7): 680-81
- **Systematic investigation of synthetic polyelectrolyte bottlebrush solutions by neutron and dynamic light scattering, osmometry, and molecular dynamics simulation.** *The Journal of chemical physics*  
Horkay, F., Chremos, A., Douglas, J. F., L Jones, R., Lou, J., Xia, Y.  
2020; 152 (19): 194904
- **Systematic investigation of synthetic polyelectrolyte bottlebrush solutions by neutron and dynamic light scattering, osmometry, and molecular dynamics simulation** *JOURNAL OF CHEMICAL PHYSICS*  
Horkay, F., Chremos, A., Douglas, J. F., Jones, R. L., Lou, J., Xia, Y.  
2020; 152 (19)

- **Facile Synthesis and Study of Microporous Catalytic Arene-Norbornene Annulation-Troger's Base Ladder Polymers for Membrane Air Separation** *ACS MACRO LETTERS*  
Ma, X., Lai, H. H., Wang, Y., Alhazmi, A., Xia, Y., Pinnau, I.  
2020; 9 (5): 680–85
- **Facile Synthesis and Study of Microporous Catalytic Arene-Norbornene Annulation-Tröger's Base Ladder Polymers for Membrane Air Separation.** *ACS macro letters*  
Ma, X., Lai, H. W., Wang, Y., Alhazmi, A., Xia, Y., Pinnau, I.  
2020; 9 (5): 680-685
- **Degradable Polyacetals/Ketals from Alternating Ring-Opening Metathesis Polymerization.** *ACS macro letters*  
Elling, B. R., Su, J. K., Xia, Y.  
2020; 9 (2): 180-184
- **Arm-degradable star polymers with crosslinked ladder-motif cores as a route to soluble microporous nanoparticles** *POLYMER CHEMISTRY*  
Teo, Y., Lai, H. H., Xia, Y.  
2020; 11 (2): 265–69
- **The cascade unzipping of ladderane reveals dynamic effects in mechanochemistry.** *Nature chemistry*  
Chen, Z., Zhu, X., Yang, J., Mercer, J. A., Burns, N. Z., Martinez, T. J., Xia, Y.  
2020
- **Precise Placement of Single Monomer Units in Living Ring-Opening Metathesis Polymerization** *CHEM*  
Elling, B. R., Su, J. K., Feist, J. D., Xia, Y.  
2019; 5 (10): 2691–2701
- **Tuning the Reactivity of Cyclopropenes from Living ROMP to Single Addition and AROMP via Simple Substituents.** *Angewandte Chemie (International ed. in English)*  
Su, J. K., Jin, Z., Zhang, R., Lu, G., Liu, P., Xia, Y.  
2019
- **Tuning the Molecular Weights, Chain Packing, and Gas-Transport Properties of CANAL Ladder Polymers by Short Alkyl Substitutions** *MACROMOLECULES*  
Lai, H. H., Benedetti, F. M., Jin, Z., Teo, Y., Wu, A. X., De Angelis, M., Smith, Z. P., Xia, Y.  
2019; 52 (16): 6294–6302
- **Benzoladderene Mechanophores: Synthesis, Polymerization, and Mechanochemical Transformation** *JOURNAL OF THE AMERICAN CHEMICAL SOCIETY*  
Yang, J., Horst, M., Romaniuk, J. H., Jin, Z., Cegelski, L., Xia, Y.  
2019; 141 (16): 6479–83
- **Varying PEG density to control stress relaxation in alginate-PEG hydrogels for 3D cell culture studies** *BIOMATERIALS*  
Nam, S., Stowers, R., Lou, J., Xia, Y., Chaudhuri, O.  
2019; 200: 15–24
- **Microporous Polyimides from Ladder Diamines Synthesized by Facile Catalytic Arene-Norbornene Annulation as High-Performance Membranes for Gas Separation** *CHEMISTRY OF MATERIALS*  
Abdulhamid, M. A., Lai, H. H., Wang, Y., Jin, Z., Teo, Y., Ma, X., Pinnau, I., Xia, Y.  
2019; 31 (5): 1767–74
- **Dinaphthobenzo[1,2:4,5]dicyclobutadiene: Antiaromatic and Orthogonally Tunable Electronics and Packing** *ANGEWANDTE CHEMIE-INTERNATIONAL EDITION*  
Jin, Z., Yao, Z., Barker, K. P., Pei, J., Xia, Y.  
2019; 58 (7): 2034–39
- **Varying PEG density to control stress relaxation in alginate-PEG hydrogels for 3D cell culture studies.** *Biomaterials*  
Nam, S., Stowers, R., Lou, J., Xia, Y., Chaudhuri, O.  
2019; 200: 15–24
- **Facile Synthesis of Macromonomers via ATRP-Nitroxide Radical Coupling and Well-Controlled Brush Block Copolymers** *MACROMOLECULES*  
Teo, Y., Xia, Y.

2019; 52 (1): 81–87

- **Dinaphthobenz[1,2:4,5]dicyclobutadiene with Strong Antiaromaticity and Orthogonally Tunable Electronics and Packing.** *Angewandte Chemie (International ed. in English)*  
Jin, Z., Yao, Z., Barker, K. P., Pei, J., Xia, Y.  
2018
- **Iterative Synthesis of Edge-Bent [3]Naphthylene** *SYNLETT*  
Jin, Z., Teo, Y., Teat, S. J., Xia, Y.  
2018; 29 (19): 2547–51
- **Synthesis and Mechanochemical Activation of Ladderene-Norbornene Block Copolymers.** *Journal of the American Chemical Society*  
Su, J. K., Feist, J. D., Yang, J., Mercer, J. A., Romaniuk, J. A., Chen, Z., Cegelski, L., Burns, N. Z., Xia, Y.  
2018; 140 (39): 12388–91
- **Efficient and Facile End Group Control of Living Ring-Opening Metathesis Polymers via Single Addition of Functional Cyclopropenes.** *ACS macro letters*  
Elling, B. R., Xia, Y.  
2018; 7 (6): 656–661
- **Synthesis of Cyclobutadienoid-Fused Phenazines with Strongly Modulated Degrees of Antiaromaticity.** *Organic letters*  
Teo, Y. C., Jin, Z., Xia, Y.  
2018; 20 (11): 3300–3304
- **Efficient and Facile End Group Control of Living Ring-Opening Metathesis Polymers via Single Addition of Functional Cyclopropenes** *ACS MACRO LETTERS*  
Elling, B. R., Xia, Y.  
2018; 7 (6): 656–61
- **A bright organic NIR-II nanofluorophore for three-dimensional imaging into biological tissues** *NATURE COMMUNICATIONS*  
Wan, H., Yue, J., Zhu, S., Uno, T., Zhang, X., Yang, Q., Yu, K., Hong, G., Wang, J., Li, L., Ma, Z., Gao, H., Zhong, et al  
2018; 9: 1171
- **Stress Relaxing Hyaluronic Acid-Collagen Hydrogels Promote Cell Spreading, Fiber Remodeling, and Focal Adhesion Formation in 3D Cell Culture** *Biomaterials*  
Lou\*, J., Stowers\*, R., Nam, S., Xia, Y., Chaudhuri, O.  
2018; 154: 213–222
- **Functionalized Rigid Ladder Polymers from Catalytic Arene-Norbornene Annulation Polymerization.** *ACS macro letters*  
Lai, H. W., Teo, Y. C., Xia, Y.  
2017; 6 (12): 1357–1361
- **Functionalized Rigid Ladder Polymers from Catalytic Arene-Norbornene Annulation Polymerization** *ACS MACRO LETTERS*  
Lai, H. H., Teo, Y., Xia, Y.  
2017; 6 (12): 1357–61
- **Stress relaxing hyaluronic acid-collagen hydrogels promote cell spreading, fiber remodeling, and focal adhesion formation in 3D cell culture.** *Biomaterials*  
Lou, J., Stowers, R., Nam, S., Xia, Y., Chaudhuri, O.  
2017; 154: 213–222
- **Synthesis of Ladder Polymers: Developments, Challenges, and Opportunities** *CHEMISTRY-A EUROPEAN JOURNAL*  
Teo, Y., Lai, H. H., Xia, Y.  
2017; 23 (57): 14101–12
- **Streamlined Synthesis of Polycyclic Conjugated Hydrocarbons Containing Cyclobutadienoids via C-H Activated Annulation and Aromatization.** *Journal of the American Chemical Society*  
Jin, Z., Teo, Y. C., Zulaibar, N. G., Smith, M. D., Xia, Y.  
2017; 139 (5): 1806–1809
- **Ring-opening metathesis polymerization of 1,2-disubstituted cyclopropenes** *CHEMICAL COMMUNICATIONS*  
Elling, B. R., Su, J. K., Xia, Y.  
2016; 52 (58): 9097–9100

- **Importance of Macromonomer Quality in the Ring-Opening Metathesis Polymerization of Macromonomers** *MACROMOLECULES*  
Teo, Y. C., Xia, Y.  
2015; 48 (16): 5656-5662
- **Living Alternating Ring-Opening Metathesis Polymerization Based on Single Monomer Additions** *JOURNAL OF THE AMERICAN CHEMICAL SOCIETY*  
Elling, B. R., Xia, Y.  
2015; 137 (31): 9922-9926
- **Synthesis and Direct Imaging of Ultrahigh Molecular Weight Cyclic Brush Polymers** *ANGEWANDTE CHEMIE-INTERNATIONAL EDITION*  
Xia, Y., Boydston, A. J., Grubbs, R. H.  
2011; 50 (26): 5882-5885
- **Efficient Synthesis of Narrowly Dispersed Brush Copolymers and Study of Their Assemblies: The Importance of Side-Chain Arrangement** *JOURNAL OF THE AMERICAN CHEMICAL SOCIETY*  
Xia, Y., Olsen, B. D., Kornfield, J. A., Grubbs, R. H.  
2009; 131 (51): 18525-18532
- **Ring-Expansion Metathesis Polymerization: Catalyst-Dependent Polymerization Profiles** *JOURNAL OF THE AMERICAN CHEMICAL SOCIETY*  
Xia, Y., Boydston, A. J., Yao, Y., Kornfield, J. A., Gorodetskaya, I. A., Spiess, H. W., Grubbs, R. H.  
2009; 131 (7): 2670-2677
- **Well-defined liquid crystal gels from telechelic polymers** *JOURNAL OF THE AMERICAN CHEMICAL SOCIETY*  
Xia, Y., Verduzco, R., Grubbs, R. H., Kornfield, J. A.  
2008; 130 (5): 1735-1740