

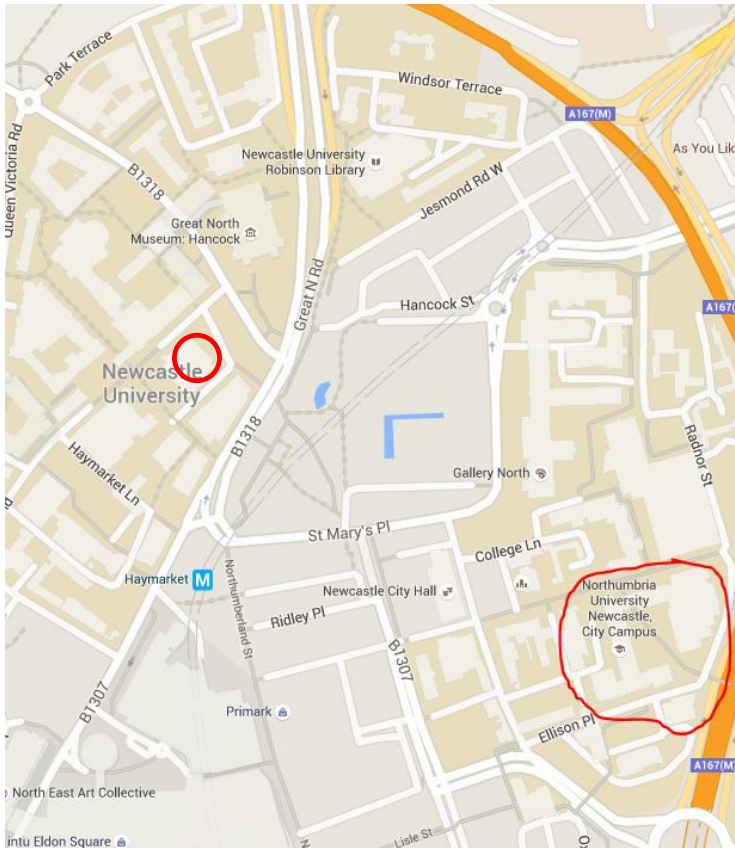
Micro-fabricated functional surfaces for future engineering

Ben B. Xu, Rodrigo Ledesma-Aguilar, Gary G. Wells, *Yifan Li*, Glen McHale

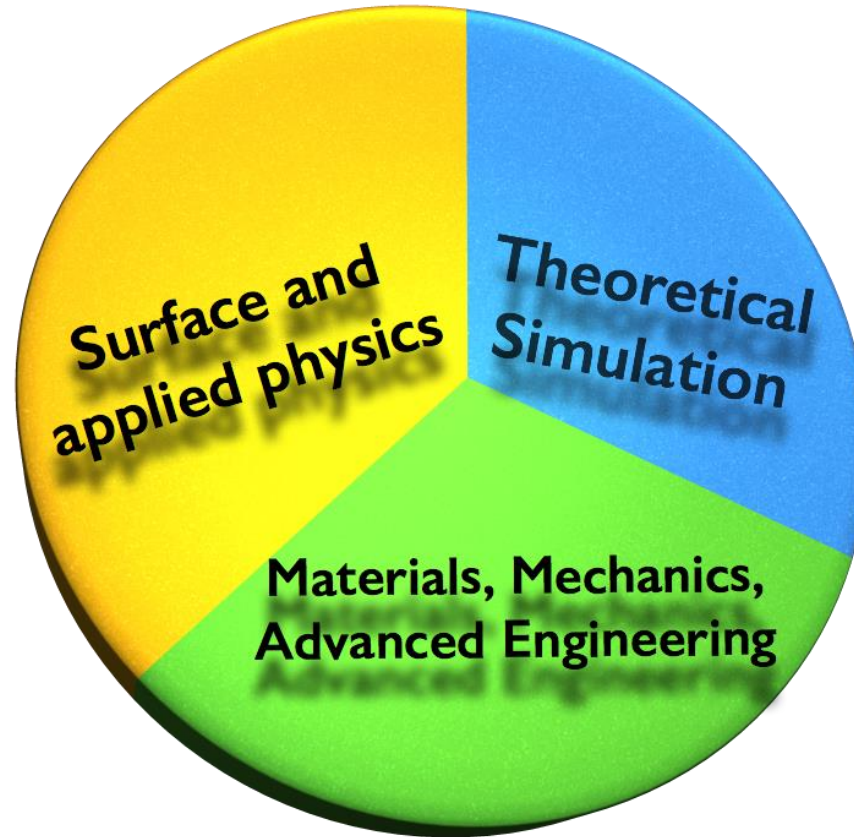
**Smart Materials and Surfaces Lab,
Northumbria University**

About us

Where are we?



What we do?



People

Prof. Glen McHale

Professor of Applied & Materials Physics

Dr. Gary G. Wells

Anniversary Research Fellow in Physics

Dr. Rodrigo Ledesma-Aguilar

Senior Lecturer in Physics

Dr. Ben B. Xu

Senior Lecturer in Mechanical & Construction Engineering

Dr. Yifan Li

Senior Lecturer in Mechanical & Construction Engineering

Group Profile



EPSRC funding (as in 2015)

- EPSRC EP/L026899/1, Lubricating channel and tube flows - Fluid sheathing using textured walls, Amount: **£528k within a £938k programme (100% FEC value)**, Duration: 2014 – 2018. (*Glen McHale and Ben Xu*)
- EPSRC EP/K014803/1, Dielectrowetting: Controlling oleo- and hydrophilicity and shaping liquid surfaces, Amount: **£350k within a £450k programme (100% FEC value)**, Duration: 2013 - 2016. (*Glen McHale*)

Selected Paper publication (2014-15)

S. A. Setu, R. P. A. Dullens, A. Hernández-Machado, I. Pagonabarraga, D. G. A. L. Aarts and **R. Ledesma-Aguilar**, Superconfinement tailors fluid flow at micro-scales. *Nature Communications*, 2015, 6, doi:10.1038/ncomms8297.

Y.Z. Jiang, Y. Li, W.P. Sun, **B. Xu**, et al, Spatially-confined lithiation/delithiation in a highly dense nanocomposite anodes towards advanced lithium-ion batteries, *Energy & Environmental Science*, 2015, 8, pp.1471-1479.

G. Wells, **R. Ledesma-Aguilar**, **G. McHale** and K. Sefiane, A Sublimation Heat Engine. *Nature Communications*, 2015, 6, DOI: 10.1038/ncomms7390.

C. V. Brown, **G. McHale**, and C. L. Trabi, Dielectrophoresis-Driven Spreading of Immersed Liquid Droplets, *Langmuir*, 2015, 31, pp. 1011–1016.

R. Ledesma-Aguilar, D. Vella, J.M. Yeomans, Lattice-Boltzmann simulations of droplet evaporation, *Soft matter*, 2014, 10, pp. 8267-8275.

B. Xu, D.Y. Cheng, R. C. Hayward. Mechanically gated transistors by creasing of patterned metal/elastomer bilayer films. *Advanced Materials*, 2014, 26, pp.4381–4385.

M. Yan, M. J. Hu, D. Zhang, T. Z. Yuan, W. P. Sun, **B. Xu**, Y. Z. Jiang. Transition metal oxides for high performance sodium ion battery anodes, *Nano Energy*, 2014, 5, pp.60-66.

Y Liu, **Y. Li**, A El-Hady, C Zhao, JF Du, Y Liu, YQ Fu. Flexible and bendable acoustofluidics based on ZnO film coated aluminium foil, *Sensors and Actuators B: Chemical*, 2015, 221, 230-235

Micro-fabricated Functional Surfaces

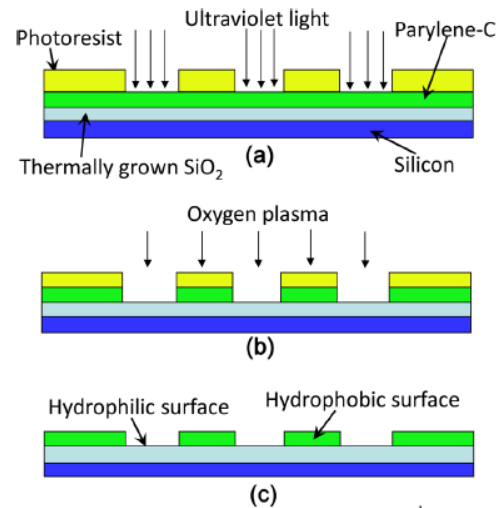
Lithography enabled micro and nano fabrication:

- Surface/bulk Etching
- Thin film Deposition
- Self-assembly
- Scalable and integratable
- Can be mass-produced
- Popular for MEMS/NEMS applications

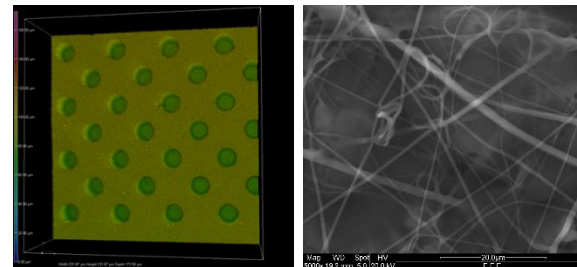
Functional Smart surfaces:

- Electro-responsive
- Mechano-responsive
- Thermo-responsive
- Magneto-responsive

Appl. Phys. Lett. 99, 073703 (2011)

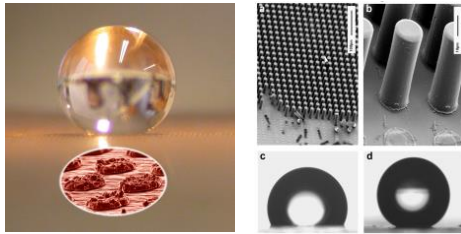


Scalable fabrication

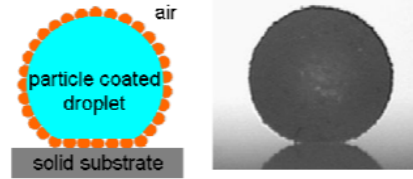


Micro-fabricated Functional Surfaces

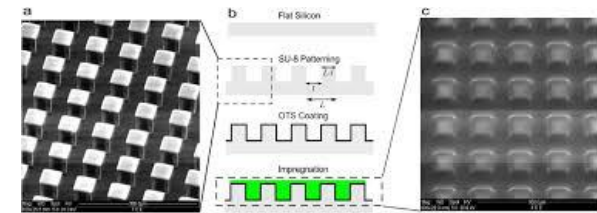
Textured Surfaces



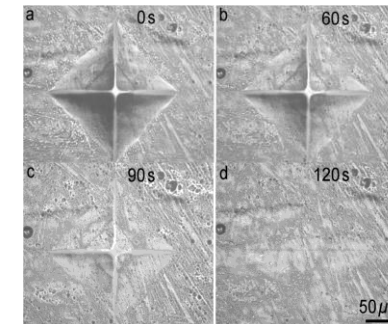
Granular Surfaces: Liquid Marbles



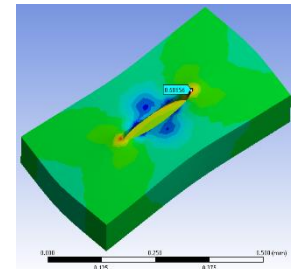
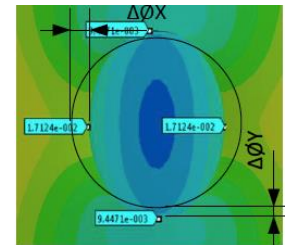
Oil infused Textured surfaces



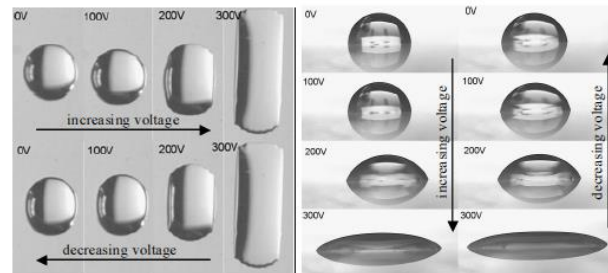
Smart materials



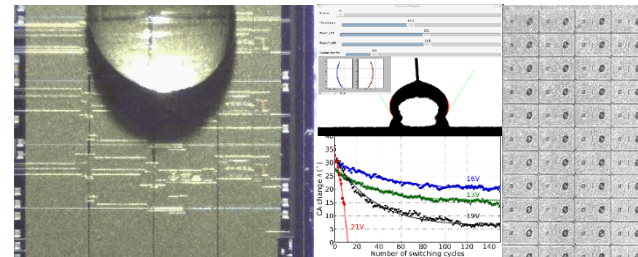
Mechanics analysis and FEA simulation



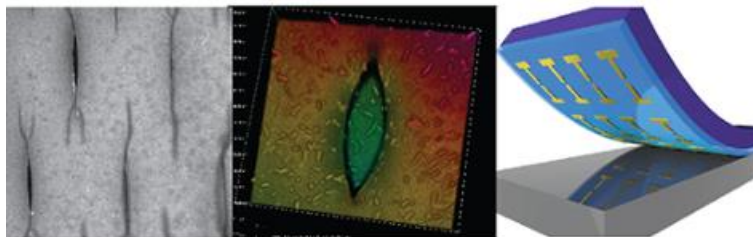
Dielectrowetting and Superspreading



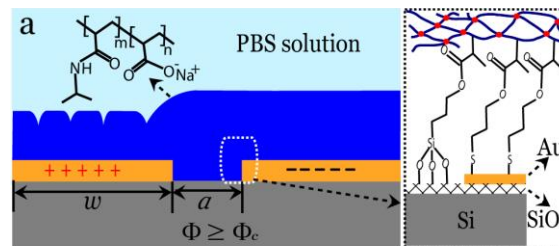
Electrowetting Surfaces



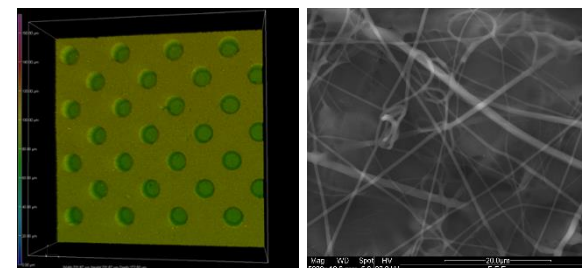
Stimuli-responsive Surfaces for advanced engineering



Engineering of Complex micro-system

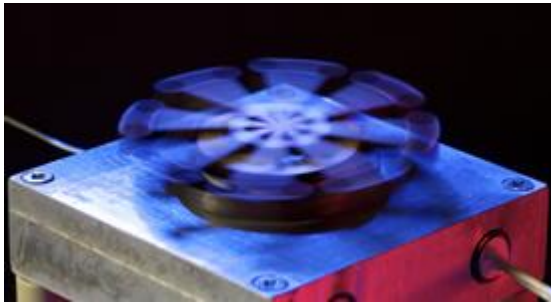


Scalable fabrication

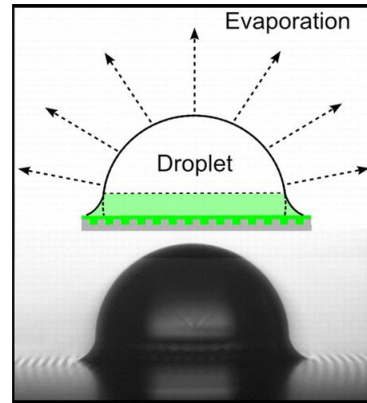


Future Engineering Applications

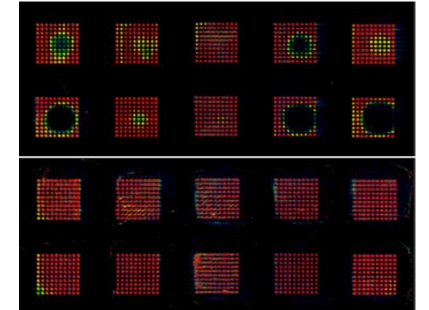
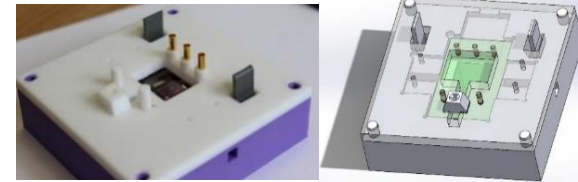
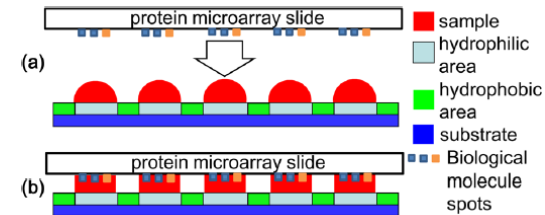
Sublimation Heat Engine: Leidenfrost Effect on patterned surface



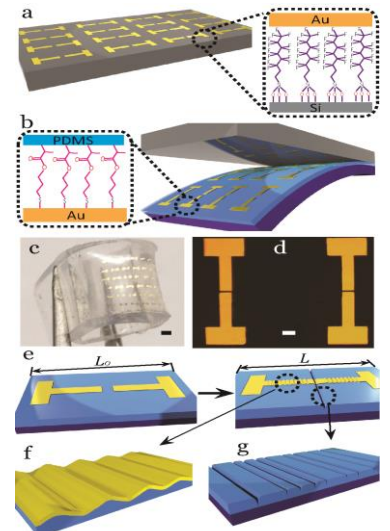
SLIP Surfaces



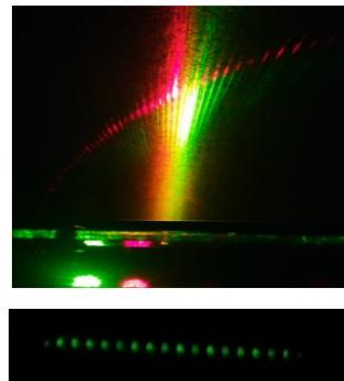
Patterned surface for small volume to area ratio Lab-on-Chip



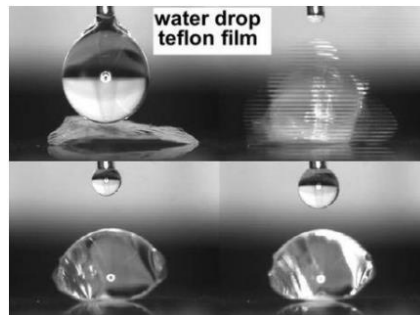
Soft lithography for Flexible/Stretchable sensors & actuators



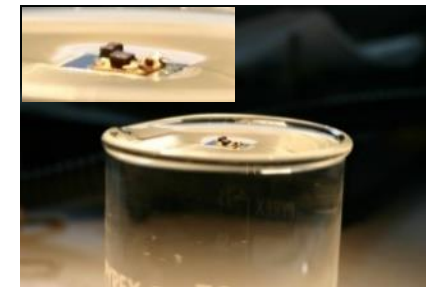
Liquid Optics



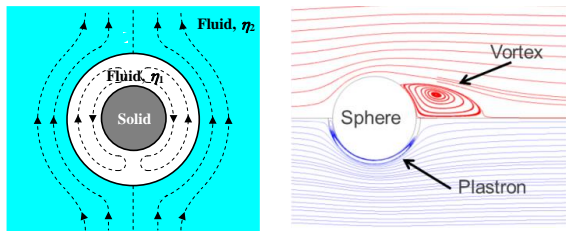
Folding surfaces: Capillary Origami



Swimming robots: Air bubble driven by Electrical Field



Drag Reducing Surfaces



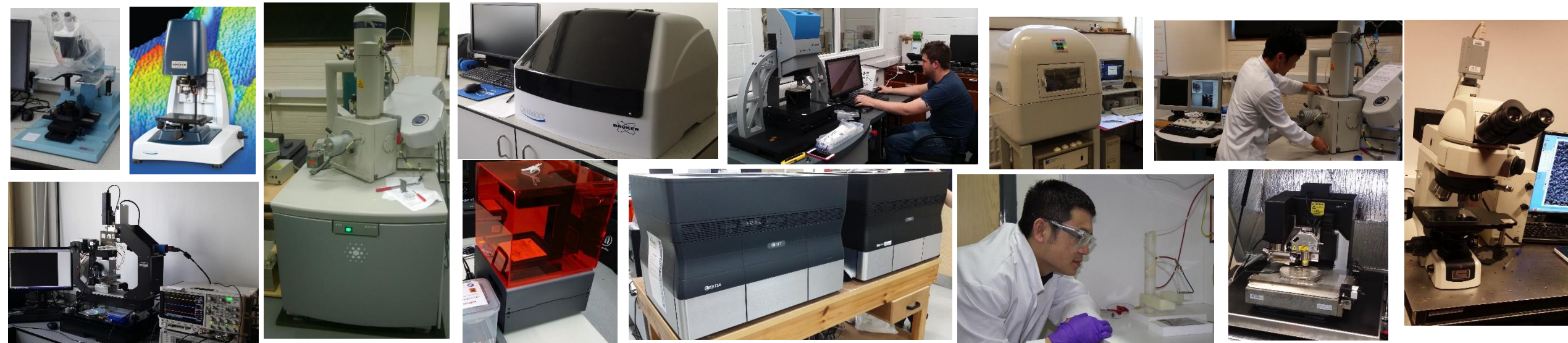
Lab Facilities

Fabrication of Materials/Surfaces

- Wet Chemistry synthesis kit in Nanotechnology standard
- Electrospinning set
- Rapid Prototyping Suite: 3D printing (various systems),
- Laser cutting,
- PCBs via milling
- Spin Coating: Elastomer surfaces
- Lithography: Mask aligner, assorted deposition, CAD

Characterisations

- Contact Profilometry
- Scanning Electron Microscope
- Krüss Drop Shape Analysis: Contact angles
- Optical Microscopy system: fluorescence, 3D surface profile, polarizing, micro-flow imaging,
- High Voltage Amplifier + Signal Sources:
- Quartz Crystal Microbalance (QCM): Surface attachment/coating experiments
- Potentiostat for electro-chemical testing
- XRD
- High Speed Cameras
- Network Analyzer,



Contact Details



Faculty of Engineering and Environment, Dept. of MCE

Yifan Li

yifan.li@northumbria.ac.uk

Acknowledgement:

All our academic and industrial collaborators;

Postdoc: Nicasio Geraldi, Zuzana Brabcova;

and PhD students: James Guan, Ding Wang, Elfego Ruiz-Gutierrez, Cong Wang.

Thank you!