A major challenge in understanding the brain is the spatiotemporal dilemma of neuroengineering: many important brain functions and cognitive processes occur in multiple regions and depths of the whole brain over months and years, but involve cellular electrophysiological changes that have to be quantified on the millisecond and micrometer scales of individual neurons. In this talk, I will present three strategies to address this major challenge in neuroengineering:

1) A near-infrared light-based in-vivo brain imaging technique ('NIR-II fluorescence imaging') through intact scalp and skull;
2) A new form of nanoelectronics ('tissue-like electronics') that resembles the neural tissue and can be delivered in the brain and the eye by syringe injection like pharmaceuticals for chronic recording of single-unit activity;
3) A minimally invasive neuromodulation interface ('sono-optogenetics) employing brain-penetrant ultrasound to produce localized light sources anytime and anywhere in the brain for neuron-type specific optogenetic stimulation through intact scalp and skull.

Dr. Guosong Hong received his PhD in chemistry from Stanford University in 2014, and then carried out postdoctoral studies at Harvard University. Dr. Hong joined Stanford Materials Science and Engineering and Neurosciences Institute as an assistant professor in 2018, and his research at Stanford aims to develop and apply novel optical and electronic materials for minimally invasive brain interfacing. He has published 70 papers in journals including Science, Nature Reviews Neuroscience, Nature Medicine, Nature Photonics, Nature Methods, Nature Biomedical Engineering, Nature Materials, Nature Nanotechnology, Nature Communications and PNAS with a total citation of >14,000. He is a recipient of the NIH Pathway to Independence (K99/R00) Award, and the MIT Technology Review ‘35 Innovators Under 35’ Award.