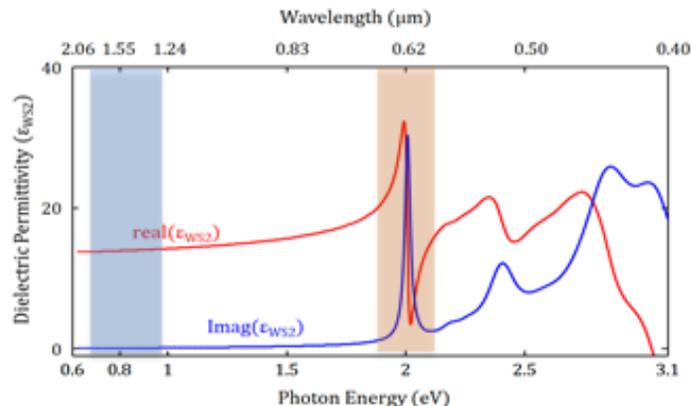


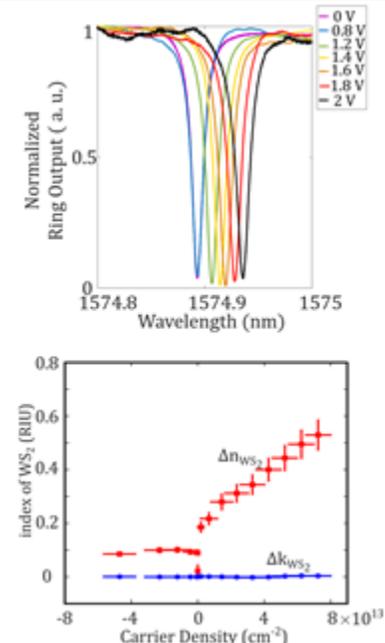
## Background and research objectives

- The optical properties of semiconductor monolayers such as TMDs are known to change drastically with doping near their excitonic resonances (orange shaded region).
- However, little is known about the effect of doping on the optical response at transparency wavelengths, far from excitonic resonances (indicated with the blue shaded region).



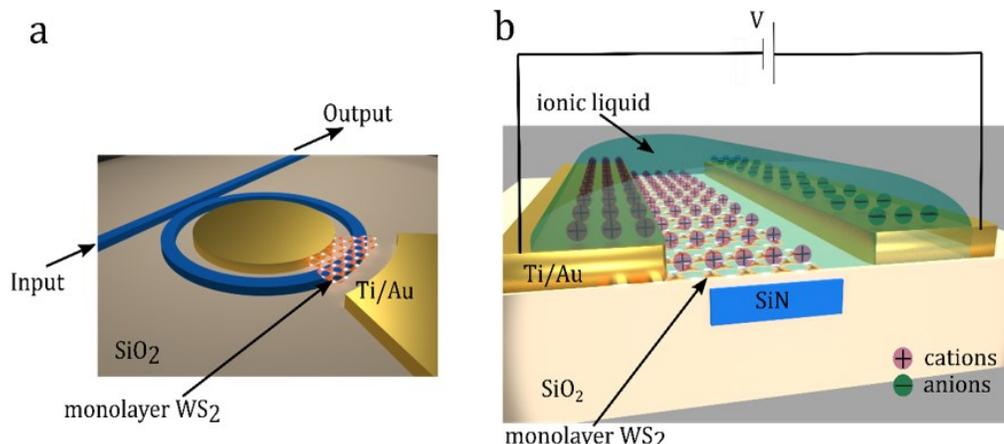
## Electro-optic tuning of optical response at transparency wavelengths

- One can see from the normalized transmission curve that as we apply a bias and dope the monolayer, the resonance wavelength shifts considerably, however the linewidth of the resonance does NOT broaden.
- We observe that change in the real part of the index due to monolayer WS<sub>2</sub> ( $\Delta n$ ) is two orders of magnitude higher than the imaginary part ( $\Delta k$ ), indicating strong phase change compared to absorption.
- This is revolutionary for photonics, now we have a material that can change phase strongly with low loss.



## Experimental methods – Photonic integration with TMD materials

- We leverage planar integrated photonic structures to enhance the optical interaction with monolayer TMDs, when compared to out of plane measurements.
- We design the optical waveguide such that the monolayer overlaps with 0.06% of the optical propagating mode. We electro-optically tune the optical response of monolayer TMDs using an ionic liquid.



## Performance efficiency

- We find that monolayer TMDs perform better as phase delays compared to conventional electro-refractive materials such as graphene, Si and III-V on silicon.
- The ability of monolayer TMDs to convert any passive substrate to active and their large-scale growth and transfer render them as ideal candidates for future generation quantum and LIDAR technologies.

