# Silicon Rich Nitride Huygens Metasurface in the Visible Regime

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**Abstract:** We experimentally demonstrate a Huygens metasurface in the visible regime utilizing Silicon rich Nitride (SRN). Offering high refractive index and CMOS compatibility, SRN is an outstanding candidate to replace the widely used TiO2.

## 1. Introduction

Dielectric metasurfaces are gaining a significant interest as a reliable alternative for plasmonic metasurfaces for optical manipulation of light due to their inherently low loss properties and the ability to shape the outgoing wavefront by tailoring the electric and magnetic multipolar resonances [1]. Therefore, there is a growing interest in structures made of high-index dielectrics that will support Mie-type resonances required for the implementation of Huygens metasurfaces. Materials such as $TiO_2$ with relatively high refractive index (~2.4) are used to construct this type of metasurfaces in the visible regime [2]. Unfortunately, these materials are not CMOS compatible and are challenging to work with. A possible solution is to use silicon rich nitride (SRN) to overcome this hurdle. It has been shown that by increasing the amount of Si in SiN the refractive index will increase while still having low losses in the visible [3]. In this work we demonstrate (theoretically and experimentally) a Huygens metasurface that operates in the visible spectral range and is made of SRN.

## 2. Methodology

We use the Plasma enhanced chemical vapor deposition (PECVD) method for depositing our SRN thin films. We can control the ratio of silicon and nitride in the sample by fine tuning the gas concentration in the chamber. We observed that both the refractive index and the extinction coefficient increase with the ratio. We achieved a refractive index of ~2.7 at 550nm with a negligible extinction coefficient allowing us to fabricate the Huygens metasurface.

## 3. Simulation and Results

Using commercially available FDTD software (Lumerical), we ran simulations of SRN disks with a fixed height and periodicity of 135nm and 360nm respectively whilst changing the radii of the disk.

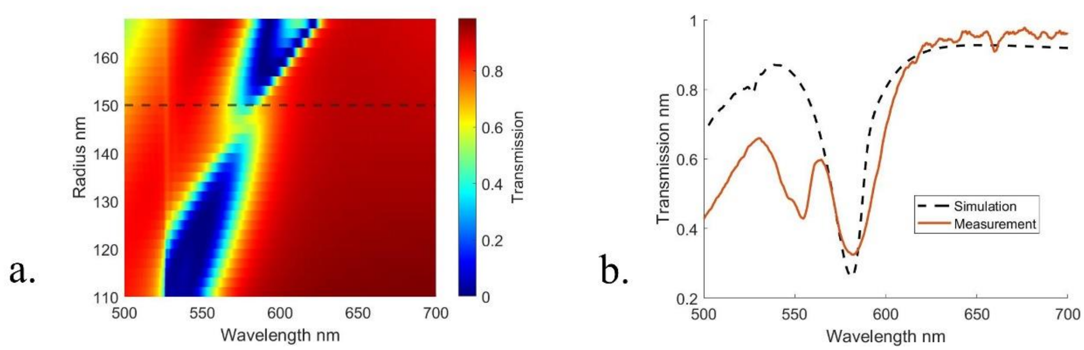


**Fig. 1** . (a) FDTD simulation of the Huygens metasurface with varying radii. (a) Cross section of (b) taken at R=150nm comparing between measured and simulated transmitted spectra.

Fig 1.a shows transmission spectra of disks with a radius varying from 110nm to 168nm. We can clearly see that the transmission spectrum reaches a local maximum indicating that the two resonances are overlapping spectrally at 575nm and that our structure is satisfying the Kerker condition [4]. Following simulations, we have measured the transmission spectrum of our device and compared it to the simulated spectrum. Indeed, we observe a spectral similarity between the two. More results will be presented in the talk, including functional devices based on our SRN based Huygens metasurface platform.

## 4. References

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