



School of Electrical and Computer Engineering
Inter-office Memorandum

Scheduling of Examinations:

Student's Name: Krishnakali Chaudhuri
Degree: Doctor of Philosophy
Type: Final Exam

Major Professor: ALEXANDRA BOLTASSEVA
Advisor 1: ALEXANDER V. KILDISHEV
Advisor 2: VLADIMIR M. SHALAEV
Advisor 3: ZHIHONG CHEN

Examination Date: 05-23-2019
Examination Time: 9:30 AM
Building & Room: BRK 2001

Thesis Title: New Material Platforms for Functional Metasurfaces

Abstract: Metasurfaces are broadly defined as artificially engineered material interfaces that have the ability to determinately control the amplitude and phase signatures of an incident electromagnetic wave. Subwavelength sized optical scatterers employed at the planar interface of two media, introduce abrupt modifications to impinged light characteristics. Arbitrary engineering of the optical interactions and the arrangement of the scatterers on plane, enable ultra-compact, miniaturized optical systems with a wide array of applications (e.g. nanoscale and nonlinear optics, sensing, detection, energy harvesting, information processing and so on) realizable by the metasurfaces. However, maturation from the laboratory to industry scale realistic systems remain largely elusive despite the expanding reach and vast domains of functionalities demonstrated by researchers. A large part of this multi-faceted problem stems from the practical constraints posed by the commonly used plasmonic materials that limit their applicability in devices requiring high temperature stability, robustness in varying ambient, mechanical durability, stable growth into nanoscale films, CMOS process compatibility, stable bio-compatibility, and so on.

Aiming to create a whole-some solution, my research has focused on developing novel, high-performance, functional plasmonic metasurface devices that utilize the inherent benefits of various emerging and alternative material platforms. Among these, the two-dimensional MXenes and the refractory transition metal nitrides are of particular importance. By exploiting the plasmonic response of thin films of the titanium carbide MXene ($\text{Ti}_3\text{C}_2\text{T}_x$) in the near infrared spectral window, a highly broadband metamaterial absorber has been designed, fabricated and experimentally demonstrated. In another work, high efficiency photonic spin Hall Effect has been experimentally realized in robust phase gradient metasurface devices based on two different refractory transition metal nitrides –titanium nitride (TiN) and zirconium nitride (ZrN). Further, taking advantage of the refractory nature of these plasmonic nitrides, a metasurface based

temperature sensor has been developed that is capable of remote, optical sensing of very high temperatures ranging up to 1200°C.

Committee Members: If you are unable to attend this examination, please contact Ms. Chaudhuri.