

MATERIALS ENGINEERING

SEMINAR

“Metal-oxide Nanocomposite for Tunable Physical Properties”

By

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ABSTRACT

Understanding how light interacts with the matter is essential for developing future optoelectronic devices. Furthermore, tuning such light-matter interaction requires designing new material platforms that is essential for developing devices which are functional in different light wavelength regimes. Among these designs, particle-in-matrix, multilayer or nanowire morphology, consisting of metal and dielectric materials, have been demonstrated for achieving improved physical and optical properties, such as ferroelectricity, ferromagnetism and negative refraction. For example, Au-TiO₂ two phase nanocomposite has been explored in this dissertation as a way of achieving enhanced photocatalysis. However, due to the availability of a limited range of structures in terms of crystallinity and morphology in the two-phase nanocomposites, a greater design flexibility and structural complexity along with versatile growth techniques are needed for developing next generation integrated photonic and electronic devices. This can be achieved by incorporating a third phase through the three phase nanocomposite designs by judicious selection of materials and functionalities.

In this dissertation, a new nanocomposite design having three different phases has been introduced: Au, BaTiO₃ and ZnO, which grow in a highly ordered ‘nanoman’-like structure. More interestingly, the three phases in the novel ‘nanoman’-like structure combine to give an emergent new property which are not found individually in the three phases. The ordered ‘nanoman’-like structures enable a high degree of tunability in their optical and electrical properties, including the hyperbolic dispersion in the visible and near infrared regime, in addition to the prominent ferroelectric/piezoelectric properties. Moreover, the growth kinetics and the thermal stability (using in-situ Transmission Electron Microscopy) of the ‘nanoman’ structures has also been studied. This study introduces a new growth paradigm of fabricating three-phase nanocomposite that will surely generate wide interests with potential applications to different systems. The ordered three-phase ‘nanoman’ structures present enormous opportunities for novel complex nanocomposite designs towards future optical, electrical and magnetic property tuning.

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