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### **Tunable plasmonic nanostructures and nanolenses in optical domain<sup>1</sup>**

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We have designed and studied various periodic metamaterials with the resonant response in the IR and optical range. In particular, the stacks of metallic films with periodic hole arrays separated by dielectric layers (fishnet, FN) have been demonstrated to have a negative index at IR frequencies. We were able to control the index of refraction of a fishnet with an amorphous semiconductor spacer layer in a pump-probe experiment [1]. This opens up ways for modulating the light at the nanoscale. We have also observed strong second- and third- harmonic generation with this metamaterial. We discuss various uses of a gain material to compensate the losses. Arrays of metallic nanoparticles or holes support individual and collective plasmonic excitations that contribute to surface enhanced Raman scattering (SERS) with thousand-fold field enhancement factor that can be used for single-molecule detection and other applications of the “light at the nanoscale.”

[1] E. Kim, et al., Appl. Phys. Lett. 91, 173105 (2007)

[2] E.V. Ponizovskaya, A.M.Bratkovsky, Appl.Phys. A 87, 161 (2007)

<sup>1</sup>In collaboration with E.V. Ponizovskaya, E. Kim, Wei Wu, Z. Yu, S-Y Wang, Y.R. Shen, R.S. Williams