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Gallium nanoparticle plasmonics YANG YANG, Dept. of Physics, Duke, PAE C. WU, TONG-HO KIM, APRIL S. BROWN, Dept. of ECE, Duke, HENRY O. EVERITT, Dept. of Physics, Duke; Army Aviation and Missile RD&E Ctr. — Gallium nanoparticles(Ga NPs) exhibit surface plasmon resonance(SPR) wavelengths that can extend deep into the UV. Because Ga NPs also possess high thermal stability and long lifetimes(months), they may be exploited for UV surface enhanced Raman spectroscopy. Raman enhancement arises from the local field factor g(w) which can be calculated using the Clausius-Mosotti relation for free standing NPs much smaller than the laser wavelength. In this case, $|g(w)|2$ for Ga NPs is >50 at a wavelength <190nm, compared to 26 for Au at 526nm and 240 for Ag at 345nm. This enhancement occurs over a much wider bandwidth in Ga(>10000 cm-1) than in Au(2100 cm-1) or Ag(6100 cm-1). To explore the potential of Ga plasmonics, molecular beam epitaxy was used to synthesize Ga NPs on solid supports. For deposition on sapphire, elevating the deposition temperature from 300K to 1000K increases Ga desorption and dramatically narrows the NP size distribution without changing the SPR wavelength. To study the role of substrate polarity, Ga NPs were also deposited at 300K on Si-polar and C-polar SiC. The mean size of NPs, which scales inversely with the surface diffusion barrier energy, is 1.8 times larger for Si-polar than for C-polar substrates. This result is consistent with the observed barrier energies 0.72eV for Si-Ga and 1.81eV for C-Ga.

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