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Producing surface plasmon polariton focusing using all-metallic devices

Joseph A. Riley[(1,2)], Noel Healy[(1)], and Victor Pacheco-Peña*[(1)]
(1) School of Mathematics, Statistics, and Physics, Newcastle University, Newcastle Upon Tyne, NE1 7RU, United Kingdom.
(2) School of Engineering, Newcastle University, Newcastle Upon Tyne, NE1 7RU, United Kingdom.

Research into finding techniques to control and manipulate surface plasmon polariton (SPP) propagation has rapidly expanded in recent decades due to the potential they have shown in a number of applications including focusing devices [1] such as plasmonic nanojets [2], nanoantennas [3] and plasmonic circuits [4]. For the design of such applications, one can exploit different methods to arbitrarily tailor the propagation of the SPPs such as shaped dielectrics including cuboids [5], micro-disks [6], and Gradient-Index (GRIN) concepts [7]. For these methods, the concept of effective media of SPPs can be exploited with one of the simplest configurations being a block of dielectric placed on top of a semi-infinite metallic surface while the whole system is immersed in air. In so doing, we can then tailor a desired response for the device (such as the effective refractive index of SPPs, n_{eff}) by properly designing the dielectric block on top of the metal. For instance, by changing the profile of the dielectric in the direction of propagation and/or changing the height of the dielectric to change n_{eff} to a desired value.

Inspired by the great potential that the arbitrary manipulation of SPPs holds for technological advancement, we propose an alternative exploitation of the effective media concept to control SPPs. We suggest the manipulation of SPP propagation without the use of dielectric components and instead replacing them using only metallic interfaces to produce ultra-compact plasmonic devices, opening up a new avenue of research into all-metallic plasmonic devices which have the potential to be completely recyclable. To design these devices we take a semi-infinite substrate made of one metal, which in the case we will discuss further at the conference is rhodium (Rh), and then insert a shaped block of another metal, which here will be silver (Ag), to produce a single well-defined focus when illuminated by incident SPPs [8]. We will show our ongoing efforts in this area in more depth during the conference and forecast some potential future directions for research and applications.

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