Abstract hybrid film leads to number density

Abstract Graphene has been widely explored for flexible, high-performance photodetectors due to its exceptional mechanical strength, broadband absorption, and high carrier mobility. However, the low stretchability and limited photo absorption of graphene have restricted itsapplications in flexible and highly sensitive photo detector. Integration ofother nanomaterials such as patterned gold nanostructures with graphenedemonstrated enhancement of light absorption by increase of light absorptionwith the nanomaterials. Recently, controlled integration of gold nanoparticles(AuNPs) with graphene including size and number density of AuNPs wasdemonstrated by simple two-step processes including thin film deposition of Auand thermal wetting. Moreover, graphene was shown to be crumple-nanostructuredby a uniform, large-area shrink nanomanufacturing technique.

Here, we present a photodetectors based on crumpled graphene integrated with AuNPs, which shows enhanced mechanical stretch ability and photoresponsivity. Thecrumpled graphene-AuNPs hybrid structures which was formed bydelamination-buckling of the hybrid film on a highly stretchable substrate, allow high stretch ability. The crumpled structures allow enhancement ofphotoresponsivity which results from the increase of optical absorption byareal densification of graphene.

Furthermore, Au nanoparticles allow plasmonicenhancement of light absorption by which more light can be efficiently absorbedwithin the nanostructures. The crumpling of graphene-AuNPs hybrid film leads tonumber density increase of AuNPs and increases optical absorption by theplasmonic enhancement. Our photodetector based on the crumpled

graphene-AuNPs hybridnanostructures shows over an order-of-magnitude higher enhancement (~1200%) ofphotoresponse compared to a flat graphene photodetector andexceptional mechanical stretch ability up to 200% together with strain-tunablephotoresponsivity.