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Mass-positioning of nanodiamonds using squeegee technique

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ABSTRACT

Fluorescent color centers in diamond nanocrystals have recently become the focus of researchers because of their potential applications in quantum information processing, nano-sensing, biomarking, and bioimaging. One of the biggest challenges in working with nanodiamonds is how to position them precisely and efficiently to create strong interaction with nanoscale photonic structures. The most popular methods to position nanodiamonds are spin-coating and transporting via scanning probe microscope tip. On the one hand, spin-coating, where nanodiamonds are randomly located, is not precise; on the other hand, the tip-based technique, where a single nanodiamond is picked and dropped, is tedious and time-consuming. Hence, we suggest a squeegee technique for mass-positioning nanodiamonds relatively precise and fast. We fabricated nanohole arrays in a 100-nm-thick silver film using electron beam and focused-ion-beam lithography techniques. In the scope of study, we found that the optimal nanohole diameter is 125nm. The proposed method for positioning nanodiamonds consists of two stages. First, we located the nanocrystals by sweeping with cleanroom wipers a droplet of a highly concentrated aqueous suspension of nanodiamonds on the fabricated nanohole arrays. Second, nanodiamonds lying outside the nanoholes are washed away by sweeping a water droplet. In order to prove the quality of the technique, we have studied the hole filling ratio using scanning electron microscopy. Our analysis showed that the filling probability is close to 100%. This technique can potentially facilitate our further experiments where nanodiamonds are coupled to nanophotonic structures.

KEYWORDS

nanodiamond, squeegee technique