Surface plasmon enhanced localization microscopy with silver nanoisland blocks

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Super-resolution microscopy has attracted attention from different research field due to irreplaceable feature of resolving biological structures and interactions inside cells. Among various attempts, near-field induced from plasmonic nanostructure could be localized to the subwavelength scale [1]. In this paper, we investigate deconvolution fluorescence imaging with silver nanoisland alignment block for inducing localized near-field [2].

For the fabrication of silver nanoisland block, a 10-nm silver film was evaporated on a BK7 glass. Through lift-off process, the alignment block only remained. With annealing at 200 °C on a hot plate, nanoisland was fabricated on the block as shown Fig. 1a. In order to obtain near-field distribution (Fig. 1b) on nanoisland, rigorous coupled wave analysis (RCWA) was used. The spatial harmonic orders set to be 40 along x and y axes. The SEM image of silver nanoisland block was converted to a binary image to model the block. J774 cell was used as target and F-actin selectively was stained with phalloidin-FITC.

The near-field distribution on the block was analyzed by ImageJ™. The average size of localized field was estimated to be 135 nm while the fields were assumed to be circular. Cell adhesion was tested by SEM because the axial penetration depth of evanescent wave is limited to 100-200 nm. After capturing raw image (Fig. 1c) data using a TIRF microscope, deconvolution was performed based on linear imaging theory, in which near-field distribution was used as a priori. Instead of direct deconvolution, which is impossible due to ill-posedness, randomly distributed fluorescence distribution was estimated and compared to raw data repeatedly. The optimum distribution (Fig. 1d) making the minimum error was found. The effective resolution was estimated to be 100-150 nm.

Fig. 1 (a) SEM image of with silver nanoisland alignment block. (b) Near-field distribution of the block. (c) Raw image of J774 cell on the block. (d) Deconvoluted image of J774 cell.