מכון אילזה כ"ץ למדע וטכנולוגיה בתחום הננומטרי
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Monitoring efficiency of ovarian cancer treatment using overtone absorption spectroscopy on microfibers

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Abstract

Cancer is the leading factor of death in the western world. However, the quantification and monitoring the response to therapy requires imaging equipment such as computed tomography (CT) and positron emission tomography (PET) scanners. This imaging equipment is bulky, costly and requires a qualified personnel to operate. Therefore, a PET-CT scan is not suitable for the bedside monitoring which delays the inspection of the treatment efficiency. Here we offer a new optical methodology based on integrated nano-photonic devices operating at telecommunication wavelengths (near-infrared) to study the efficiency of cancer treatment and to improve the care of cancer patients.

Methodology

We study the optical mode evolution in microfiber, shown in Figure 1, while varying the diameter of the core in an aquatic medium.

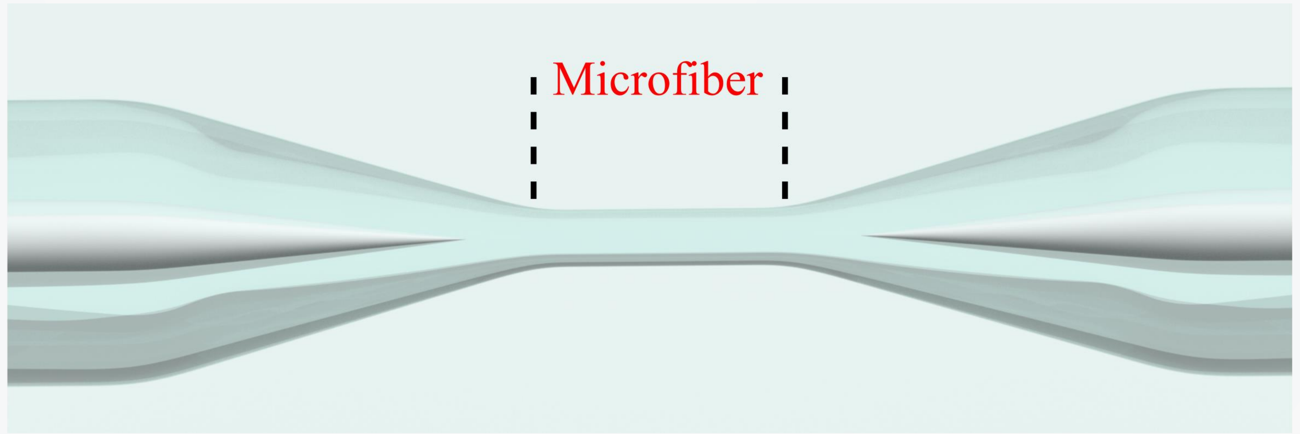

Figure 1 - Illustration of a tapered fiber structure.

For the optimal squeezing dimensions for the fiber, we calculate the fraction of the power in the evanescent field:

$$\eta = \frac{P_{evanes}}{P_{total}} = \frac{\int_{analyte} SdA}{\int_{-\infty}^{\infty} SdA}$$

with time varying Poynting vector - S:

$$S = \frac{1}{2}\Re\{E \times H^*\}$$

Figure 2 shows an increase in the fraction of the power in the evanescent field due to the minimization of the microfiber radius.

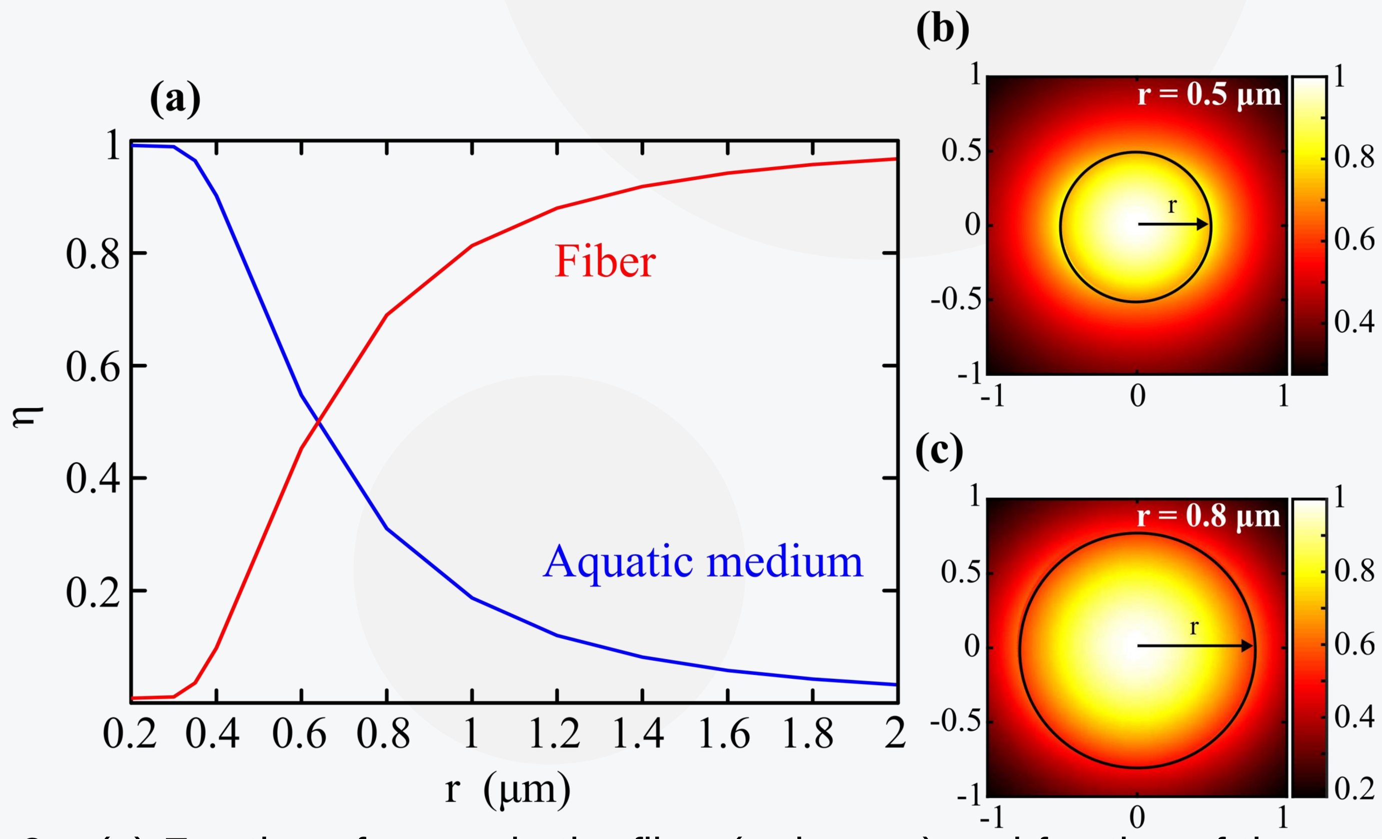

Figure 2 – (a) Fraction of power in the fiber (red curve) and fraction of the power in the medium while the microfiber is embedded in the index of 1.33 (blue curve) - both with changing the microfiber radius for the wavelength of 1.5 μm. (b)-(c) The normalized electric field distributions for various microfiber radii.

Based on our calculations, we fabricated tapered fibers with microfiber region diameter of ~2.5 μm to enhance the fraction of the evanescent field.

Results

We built the experimental setup which is shown in Figure 3. We coupled a broadband laser source to the tapered fiber and dripped the liquid with cancer cells onto a Teflon spacer.

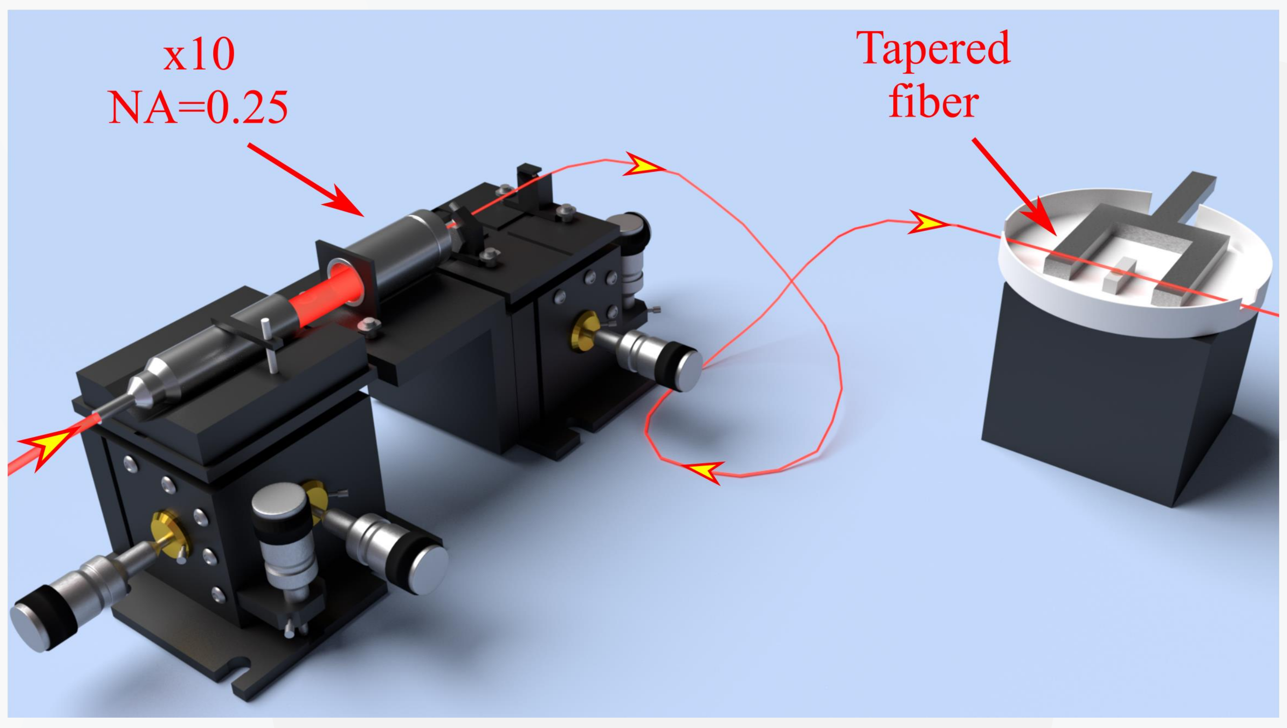

Figure 3 - Illustration of the experimental set-up.

Figure 3a shows the optical image of ovarian cancer cells - IGROV1. Figure 3b shows the normalized transmittance spectra of the cancer cells. Each curve shows different concentrations of the medicine.

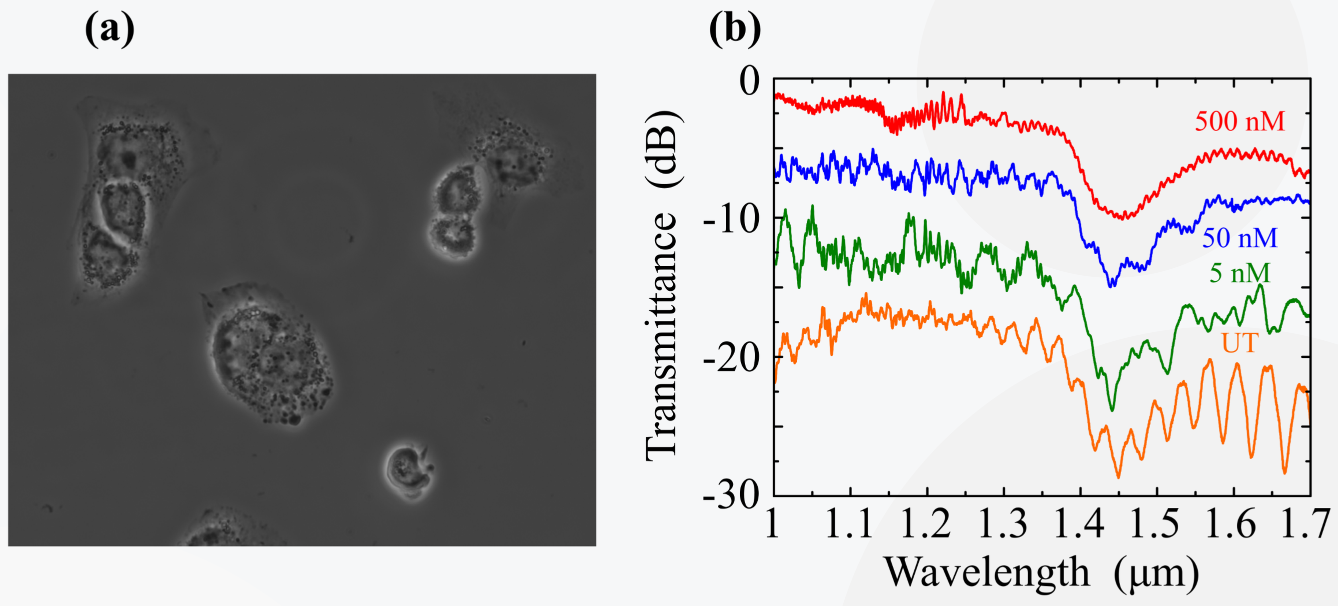

Figure 4 - (a) Image of IGROV1 ovarian cancer cells. (b) The transmittance spectra of IGROV1 cells responding to different medicines.

Conclusions

To conclude, we studied the efficiency of cancer treatment with microfibers. The cancer cells were monitored for 2 minutes showing characteristic overtone signatures. Using the proposed by us technique, relatively fast detection of tumors respond to treatment in an accurate manner, 24 hours after the treatment, would be possible.

Acknowledgements

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