the metal surface compared to the outer interface with a sample [24] and thus the density of dyes attached to individual IgG molecules is likely gradually decreasing when increasing the distance from the metal surface. Lastly, let us note that the measured enhancements for the excitation of the fluorescence light intensity via LRSPs and regular SPs, respectively, are comparable to the calculated average field intensity enhancement of $|\mathbf{E}|^2_{ave}/|\mathbf{E_0}|^2$ = 37 and 8, respectively. However, the presented work shows that besides increasing the excitation rate by large field intensity enhancement, also careful design of fluorescence decay channels needs to be addressed in order to achieve maximum sensitivity of fluorescence light detection.

## 4. Conclusions

We investigated the long range surface plasmon-assisted excitation and emission of fluorophore-labeled molecules captured in a large-binding capacity hydrogel matrix. These surface plasmon modes offer the advantage of lower damping, more extended profile of electromagnetic field and higher field intensity enhancement with respect to regular surface plasmons. The obtained experimental data measured by using the ATR method with Kretschmann configuration exhibited good agreement with simulations. It revealed that, compared to regular surface plasmons, the combined excitation and emission via long range surface plasmons allowed increasing the peak fluorescence intensity with a factor of 4.4 and squeezing the emission in a cone that exhibited 6-fold narrower full width in half maximum. The results indicate that probing the hydrogel interface by LRSPs and regular SPs leads to similar total fluorescence light intensity collected through the surface plasmon-coupled emission. However, the employing of LRSPs offers the advantage of excitation and emission at lower angles which can simplify the implementation of this method to practical biosensor devices. In addition, the highly directional emission manifested as a narrow emission peak can be more efficiently filtered from the background signal and it can be useful for e.g. angular multiplexing of sensing channels. Our future work will be devoted to the suppressing of competing emission via LRSPs and SRSPs modes by using (nano)structured metallic films and to the implementation of combined SPFS and SPCE with LRSP modes to compact biosensor devices.

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