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INVESTIGATION OF TES-ADT BASED NIR-TO-VIS PHOTON UPCONVERSION SYSTEM

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Triplet-triplet annihilation based NIR-to-visible photon upconversion (TTA-UC) is a photophysical process used to generate visible photons from low power density incoherent NIR excitation [1]. Due to forementioned qualities, UC could become handy in various practical applications such as harvesting sub-bandgap photons in photovoltaic devices, using UC materials in night vision equipment, photopolymerization and other fields of science and technology [1-3]. Typically, TTA-UC systems are composed of two types of molecular species: sensitizer and emitter. The first one is used for NIR light absorption and triplet generation, whereas emitter is responsible for triplet-triplet annihilation (TTA) and visible light emission. Rubrene molecule is the most popular emitter option in the field, yet due to aggregation it shows poor performance in solid-state [2]. Modified antradithiophene (TES-ADT) could become a suitable replacement for rubrene and other widely used emitters, due to promising solid-state performance [3] and low triplet state energy. Therefore its photophysical properties in various UC systems should be thoroughly studied.

The aim of this research is to investigate liquid TES-ADT based TTA-UC system. To obtain UC the TES-ADT emitter is coupled with palladium phthalocyanine (PdPc) sensitizer. Experimentally, a series of 8 UC samples with constant sensitizer and varying emitter concentration ($1 - 200$ mM) was made to determine the optimal TES-ADT concentration for the best TTA-UC performance. The performance was evaluated by measuring UC quantum yield (Φ_{UC}) using integrating sphere and comparative methods. The results (see Fig. 2) show that 20 mM emitter solution yields the highest value of around $\Phi_{UC} = (7{,}7 \pm 2{,}7)\%$ (Fig. 1-2). Moreover, it is shown that lower emitter concentrations result in poor triplet energy transfer, whereas higher than optimal amount of TES-ADT evoke aggregation indicated by the drop of the fluorescence quantum yield from 100% to 11%. High Φ_{UC} values obtained, motivate further research and possible applications in solid-state.

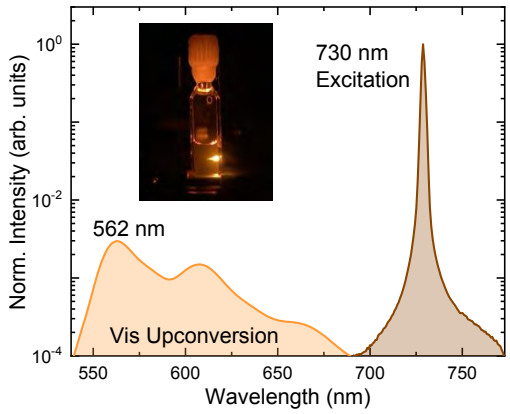

Fig. 1. UC spectrum in Vis region of TES-ADT:PdPc (10 mM:15 μM) solution under 730 nm CW excitation.

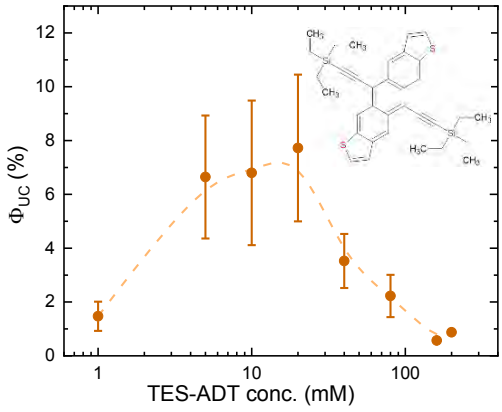

Fig. 2. UC quantum yield of samples with constant PdPc concentration (15 μM) and variable emitter concentration in toluene.

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