

The rapid development of molecular electronics effect on lowering the cost of production of optoelectronic circuits like OLED displays. On the other hand, the high demand for thin-film, flexible matrix OLED contributed to the increase in demand for rare and very expensive iridium, which is the main component of typical phosphorescent emitters. In order to eliminated iridium based compounds, scientists began to look for another way to increase the efficient emitters. From a physical point of view, the luminescence process can be divided into two processes fluorescence and phosphorescence, where the first is a rapid process in which the molecule from the singlet excited state returns to the ground state by emitting energy in the form of photons. Phosphorescence is a long lived process associated with moving molecules from singlet excited state to the triplet state. This transition is a quantum forbidden transition and for that the process of Intersystem Crossing (ISC) takes longer. Then, excited triplet state of the molecule relaxes to the ground state. Inside the organic light emitting devices (OLED) after applying potential (charge), electrons and holes in the active substance can be combined to form different excited states, such as the singlet excitonic state and triplet excitonic state. When the charge singlet excitons and triplet, which should theoretically be produced in a ratio of one to three, are formed. In the case of devices based on the fluorescence emission process of fluorescence emission is caused only by the decay of singlet excitons, the state of triplet exciton is prohibited. Quantum yield for singlet excitons is limited to 25%, which means that the triplet excitons is 75%. So far, in the industry one of the ways to improve the process efficiency of light was the use of the phosphorescence process and forming PHOLEDs (Phosphorescence Organic Light-Emitting Diodes). Unfortunately, efficient phosphorescence emitters contain a very expensive iridium and quantum efficiency of real devices is below 15% and the operating voltage above 4 V, which results in a large loss of energy and a shorter lifespan. The innovative idea to increase device efficiency, is to link the process of fluorescence and phosphorescence and to obtain 100% yield by employing the E-type delayed fluorescence (E-DF) also called TADF (Thermally Delayed Fluorescence Activated). In general terms, it means that the molecule from the triplet excited state is going back to the singlet excited state, and then relaxes to the ground state by emitting photons. In this process, excited singlet state and a triplet must have very similar energies. Thanks to that with small amount of energy, molecule is able to move from the triplet excited state back to the singlet excited state, and relax with emission of light. The maximum yield of this process is 100%.

In my project, I will try to use the thermally activated delayed fluorescence (TADF) process for various mixed layers of donor-acceptor (exciplex) as OLED emitter and studied the influence of morphology and thermal properties of layers on emission in order to improve efficiency up to 100% (more than 15% EQE). Such stable systems will help in the future eliminate expensive iridium based compounds in diodes and OLED displays.