Safety relevant ignition processes – Ignition by electrical discharges

Spark ignition by low-energetic electrical discharges in combustible fuel/air mixtures is a significant safety risk in various industries. Experimental measurements and numerical simulations of the ignition and early flame propagation of hydrogen/air, propane/air and ethene/air mixtures will be discussed. The experiments, carried out at different energy levels close to the respective minimum ignition energy (MIE), show that higher energy input leads to a wider flame radius, which is in agreement with one-dimensional numerical simulations. Further, the highly stochastic nature of the ignition process if the introduced energy is near the respective MIE will be examined. By utilizing the combined methodical approach of experiments and simulations, the key factors impairing the experimental repeatability of the ignition are identified. One important influencing factor is the three-dimensional flow induced by the electrical discharge, effectively increasing the experimental scatter. The presented work facilitates a detailed view on the complex physiochemical mechanisms dominating ignitions of explosive gas mixtures by low-energetic electrical discharges.