An experimental investigation of the phosphorescence properties of liquid and vapour acetone is presented with the goal of introducing a novel technique for improved two-phase flow visualization. Commonly applied laser induced fluorescence (LIF) investigations of two-phase flows are challenging, in particular because of the large disparity in fluorescence intensity between the two phases and the ensuing effect of halation around the liquid droplets. The very strong signal from the liquid introduces a crosstalk with the neighbouring pixels (which contain the weak vapour phase signal), and results in an apparent increase in the spatial extent of the liquid or in an over-prediction of the vapour phase concentration near the interface. The phosphorescence properties of liquid and gaseous acetone are utilized in order to decrease this disparity and eliminate the halation, and hence, to acquire more quantitative images of the evaporated tracer surrounding the droplets. For this purpose, the phosphorescence decay of acetone vapour in air and nitrogen bath gas, as well as the decay of liquid acetone at different boundary conditions was characterised for an excitation wavelength of 308nm.

Acetone vapour in air does not emit phosphorescence due to strong oxygen quenching; however, in nitrogen, a slowly decaying signal with a lifetime of around 920ns is observed. The liquid acetone phosphorescence is strongly affected by self-quenching, as well as by quenching from oxygen which is dissolved in the liquid. The phosphorescence lifetime of liquid acetone in air bath gas which has been previously exposed to ambient air for a prolonged period of time is 73ns. When, in contrast, liquid acetone is degassed (purged with nitrogen in order to remove any dissolved oxygen), its lifetime in nitrogen bath gas increases to 213ns. Non degassed acetone in nitrogen bath gas or degassed acetone in air bath gas show different lifetimes between these two extremes.

A direct comparison of the phosphorescence intensities of liquid and vapour acetone has revealed the potential to optimize the mentioned disparity between the two signals for two-phase flow imaging. In order to demonstrate the effectiveness of collecting the phosphorescence rather than the fluorescence emissions, experiments with an acetone droplet stream were conducted in different environments. Figure 1 shows an example where a stream of acetone droplets in saturated acetone vapour in nitrogen is imaged using fluorescence and phosphorescence imaging. With LIF, strong halation around the droplets resulted in both, an apparent increase in the spatial extent of the droplets and an over-prediction of the vapour phase concentration near the interface (cf. Fig. 1(c)). In contrast, the phosphorescence image in Fig. 1(d) allows for the liquid-vapour interface to be accurately located and for the vapour phase to be clearly visible.

**Fig. 1** Results from a non-evaporating stream of acetone droplets in saturated acetone vapour in nitrogen. (a) White light image of a droplet stream under diffuse background illumination. (b) Fluorescence image of the stream with 0-1000 counts dynamic range (c) The same fluorescence image presented with 0-100 counts dynamic range. (d) A phosphorescence image of the droplet stream.