Synthesis of nonspherical magnetic particles in supercritical fluids

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The gas-liquid coexistence curves terminate at the critical points [1]. Fluids located above the critical points are called supercritical fluids (see Fig. 1). Supercritical fluids have been utilised for cleaning substrates, extracting molecules, encouraging chemical reactions and synthesising materials in recent years. Magnetic particles are of great importance particularly in biomedical science and technology [2,3]; e.g., magnetic particles can be utilised for MRI imaging, hyperthermia treatment and drug delivery. In this study, we synthesise magnetic particles in supercritical fluids, dissolving ferrocene in acetone and ethanol under supercritical conditions. The molar volume of acetone and ethanol and the temperature are changed (see Figure 1). The structures of the particles are observed by scanning electron microscopy (SEM) and the elemental analysis is carried out by energy dispersive X-ray spectroscopy (EDS). The magnetisation is measured by a superconducting quantum interference device (SQUID). We find that spherical particles are produced at 250 and 300 °C, whereas nonspherical particles are synthesised at 350 and 400 °C in both acetone and ethanol. The magnetisation increases with an increase of the synthetic temperature. We explain the detail of the shapes, structures and magnetic features of those particles at the poster session.

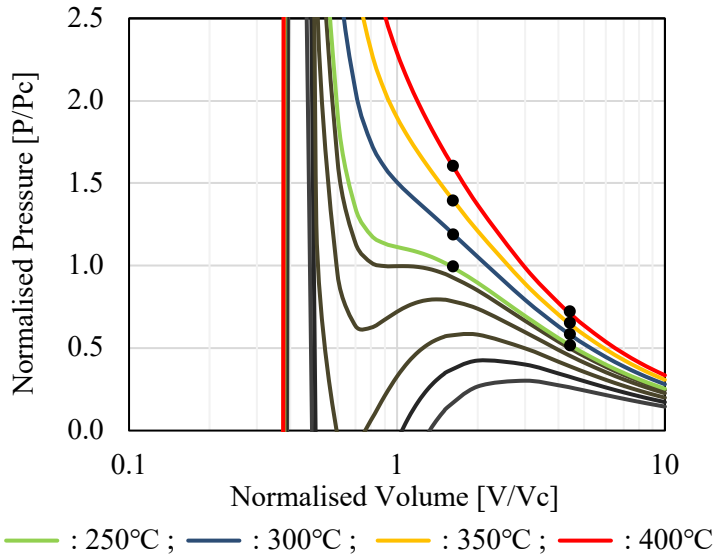

Figure 1. Phase (P-V) diagram of acetone

• represents the pressure, volume and temperature under which the present experiments were carried out.

References

[1] H.E. Stanley, *Introduction to phase transition and critical phenomena* (Oxford: Oxford University Press (1971).
[2] G. Mary, et al., High-throughput differentiation of embryonic stem cells into cardiomyocytes with a microfabricated magnetic pattern and cyclic stimulation, *Adv. Funct. Mater.* **30**, 2002541 (2020).
[3] D. Piché, et al., Targeted T_1 MRI contrast enhancement with extraordinarily small $CoFe_2O_4$ nanoparticles, *ACS Appl. Mater. Interfaces* **11**, 6724-6740 (2019).