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Unlocking the properties and dynamics of commercial oil additives using SANS

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Additives are used in lubricant systems to minimise destructive processes in the engine (e.g. wear and corrosion) and to confer beneficial properties (e.g. more uniformed viscosity with temperature and improved fuel economy). Lubricant formulations typically up to 10 ingredients, comprising mixtures of amphiphilic species: surfactants, polymers, sols and inorganic salts dispersed in non-aqueous media. Producing stable formulations with the requisite performance properties is vital to successful product development. In collaboration with Isabelle, the D22 Small Angle Neutron Scattering (SANS) instrument at ILL has been used to investigate the mechanism and dynamics of product performance and stability.

- Mechanism of Product Performance: Overbased detergents are an integral element of additive systems, comprising surfactant stabilised calcium carbonate particles. Such particles represent "model" hard-sphere systems with narrow polydispersity and mean core radius in the range 2 – 5 nm. They are used to neutralise acid species introduced into the lubricant through acidic blow-by gases. In addition, the detergent helps maintain piston cleanliness. With the increased use of exhaust gas recirculation in diesel engines (used to reduce the level of NOx by reducing combustion temperature), there is increased interest in the factors affecting acid neutralisation kinetics. The mechanism of acid neutralisation for small, acid-containing microemulsion droplets and for larger (acid containing) emulsion droplets the SANS measurements have been performed as a function of percentage neutralisation.
- Surfactant Competition influencing stability: Interaction/ competitive adsorption between lubricant additives can result in product instability. Stopped flow SANS has been performed on specially deuterated commercial additives to investigate the mechanism and dynamics of such interactions.

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