S2 New Flowable OD and SE Technologies for Enhanced A.I. Biodelivery

The Opportunities and Challenges they pose for the Formulation Scientist

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Today, there are many drivers towards maximising the benefits and minimising unwanted side effects of a.i. molecules; these include reduced amounts of a.i.s on crops and reduced losses to the environment on one side and increasing a.i. costs, increasing Mw and decreasing solubility and bioavailability on the other. To help meet these challenges more advanced formulations are required that maximise biodelivery of the a.i. to the target. This creates opportunities for the formulation scientist to design advanced OD, SE and adjuvant containing SC formulations with enhanced biodelivery. However, the stability of these formulations is often much more complex than normal SCs and here the standard models for stability are often not valid and newer models of understanding with a greater scientific input are important. This is particularly true for OD formulations which arguably offer both the greatest opportunities and challenges, as illustrated by their recent success in Europe.

The majority of flowable formulations are stable to gravitational separation due to the presence of a particle network which on one hand is sufficiently strong to resist gravity yet on the other hand is sufficiently weak to be able to break, pour and empty from the pack. The balance between these competing requirements is important in defining the quality of the formulation in the eyes of the customer. Rheology is one of the few widely available techniques that can be used to probe this elastic gel microstructure and the interparticle forces at one extreme and the bulk mechanical properties: stability, processing and end user properties at the other. In order to achieve this, an understanding of the formulation at the microscopic scale is required where the rheology results can be interpreted in terms of the interparticle interactions and microstructure. Through this understanding the Formulation Scientist can then modify these aspects to achieve the desired properties in the formulation.

Many flowables are not static but are "living" systems exhibiting ageing effects such as Ostwald ripening of particles, network coarsening and "transient gels" where sudden phase separation occurs after a delay period. Prediction of these ageing effects is difficult, especially with advanced flowables where ageing processes are often more complex, and special non-destructive vane techniques that can be inserted periodically into ageing samples allow valuable insights into the time dependent processes and gel stability to be obtained.

Creating a stable formulation is only part of the formulators challenge since it must also give the required biodelivery on the crop. Annulus “coffee ring” deposits are commonly formed by drying spray drops containing suspended particles. When a second component is included such as an adjuvant, deposit microstructures can result where the two components are either associated or segregated resulting in enhanced or reduced biodelivery respectively. These different structures are governed by the various colloidal and interfacial forces acting on the system and understanding these and how to manipulate them can allow preferred microstructures to be formed.

The presentation will illustrate each of the above aspects and how knowledge of these can allow the Formulation Scientist to produce flowable formulations with enhanced performance.