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The Nanomorphological and Kinetic Evolution of Soft-Solids as Probed by Fluorescence

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Fluorescence techniques based on tracking the photophysical properties of a molecular probe to indicate changes in local environment have earned a well-deserved reputation. This is because fluorescence has high sensitivity, even single molecules can be readily detected, and it can be observed on a time frame spanning femtoseconds to typically microseconds, giving fluorescence the potential to resolve the many complex physical properties of soft solids.

Of the many soft-solid materials commonly studied by fluorescence techniques over the past two decades, one in particular stands out, namely sol-gel materials. This is probably because there are few more important materials than silica and water; the former constitutes the most abundant material in the earth's crust and the latter occupies most of the surface of the earth. The combined properties of the two are inextricably linked in the search for a better understanding of the molecular dynamics responsible for the sol to gel phase transitions that underpin applications as diverse as cleaning agents, fining agents, polishing, printing and adhesives, to name but just a few. Moreover, because of their ease of forming an optically clear glass, even when doped with high concentrations of aromatic dyes, these soft solids make excellent fluorescent matrices for use as laser gain media, solar collectors, nonlinear optical components, and sensors. Further, the ease of molding these materials, their graded refractive index capabilities and a typically shorter wavelength of transmission than silica fused at high temperatures, has fueled research in studying their nanomorphological and kinetic evolution. Only from a better fundamental understanding of soft-solid formation at the molecular level we will be able to design and tailor specific materials.

Sol-gels still remain an interesting challenge when we realise than the sol-gel process, which owes its origins to the pioneering work of Graham and Ebelman in the 19th Century, still has many fundamental questions remaining unanswered, for example, how is the structure memorized from the sol to the gel, and what are the role and relation of the silica nanoparticles in pore formation and therefore gel surface area. Such answers are critical for a better understanding of silica-based materials, such as silica gel and chromatography silicas, which are multimillion dollar industries worldwide.

In this special issue we have invited leading-edge scientists who have engaged these different complex questions and sought answers using a variety of fluorescence techniques and methodologies, such as using polarity sensitive probes, fluorescence lifetimes, and approaches based on fluorescence anisotropy. We have organized this *Special Issue* in such a way as to include contributions that will hopefully give readers a chance to visualise the extent of research currently being undertaken in this important area.

In conclusion, I would like to thank all the authors for their invaluable and timely contributions, which demonstrate the power of fluorescence for providing both kinetic and structural information on silicates, silicas, sol-gels, and soft solids in general, in which more often than not, many physical processes overlap or occur simultaneously, making them difficult to study by other techniques.

Finally, in closing, I would like thank Mary Rosenfeld for helping me put this special issue together.

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