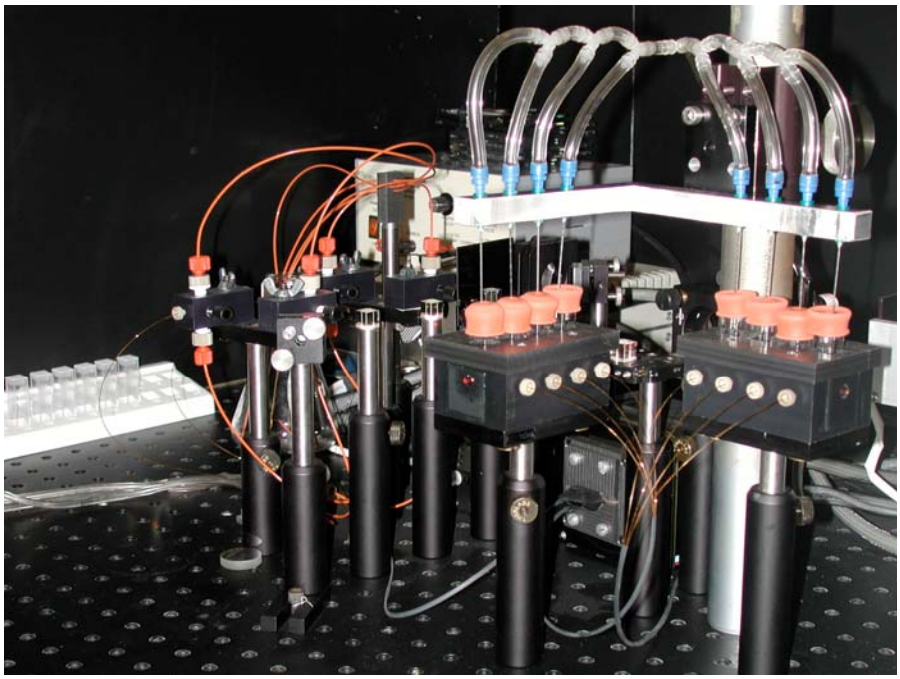
Simultaneous Multiple Sample Light Scattering (SMSLS)*

SMSLS collects the scattered light simultaneously from multiple independent samples in which time dependent processes may be occurring. It has been conceived as a tool for high throughput screening in a number of contexts; to screen the long term stability of polymer and/or colloid solutions against instabilities such as aggregation, degradation, phase separation, microcrystallization, and so on. It can also be used to follow polymerization reactions.

Light scattering practice until now has focused on obtaining accurate measurements on single samples. This is still useful in many contexts, but when discovery and development of new materials is rate-limited by analysis, the use of SMSLS can increase efficiency by literally orders of magnitude.

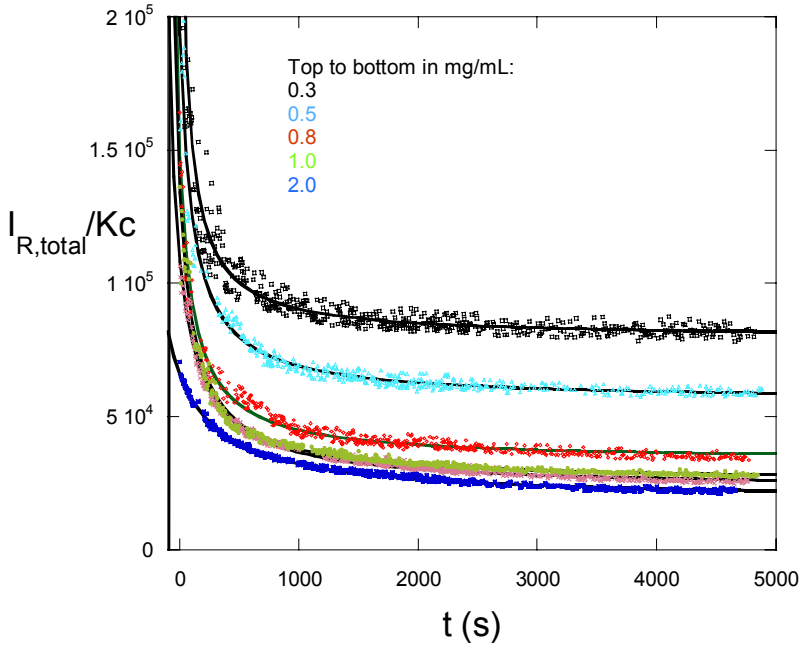
Imagine, for example, a pharmaceutical formulation is to be made involving a large matrix of solution conditions, such as drug concentration, ionic strength, pH, supporting molecules, etc., and that the goal is to make a formulation that is stable for months at a time. It is absurd to think of tying up an expensive, single sample light scattering device for months in order to test a single formulation! If, however, we use an SMSLS system with, say, 500 independent cells, each one of which is separately and continuously monitored for as many months as desired, it quickly becomes feasible to massively test huge matrices of conditions in parallel. Each sample will have its own complete history, including any benchmark conditions that validate or invalidate its usefulness. It is also possible to change out at any time any samples that have failed their tests without interrupting any of the other tests in progress. Light scattering is exquisitely sensitive to even minute changes in molecular mass, so, for example, any protein aggregation will be immediately detected if it begins to occur.

Below is a photo of a recent prototype built by graduate student Michael Drenski. It includes 12 independent chambers, 4 of which are flow cells, and eight of which are insertable cuvettes in an index matched bath. There are no fundamental limits on how many independent cells can be used in a given apparatus. It has been demonstrated that sensitivity and stray light suppression are as high as usual commercial single sample instruments, and that absolute values of M_w can be obtained.

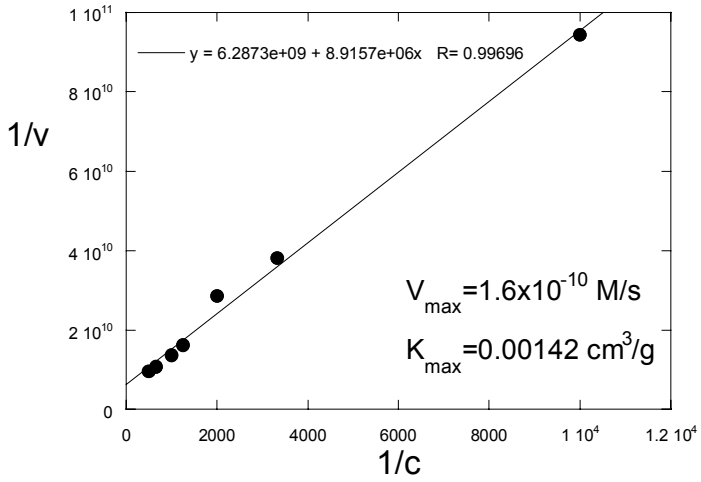


Data from the degradation of sodium hyaluronate by hyaluronidase is shown below, together with the Michaelis-Menten approach to the corresponding enzyme kinetic analysis.

(from M.F. Drenski, W.F. Reed, J. App. Polym. Sci., vol. 92, 2724-2732, 2004)

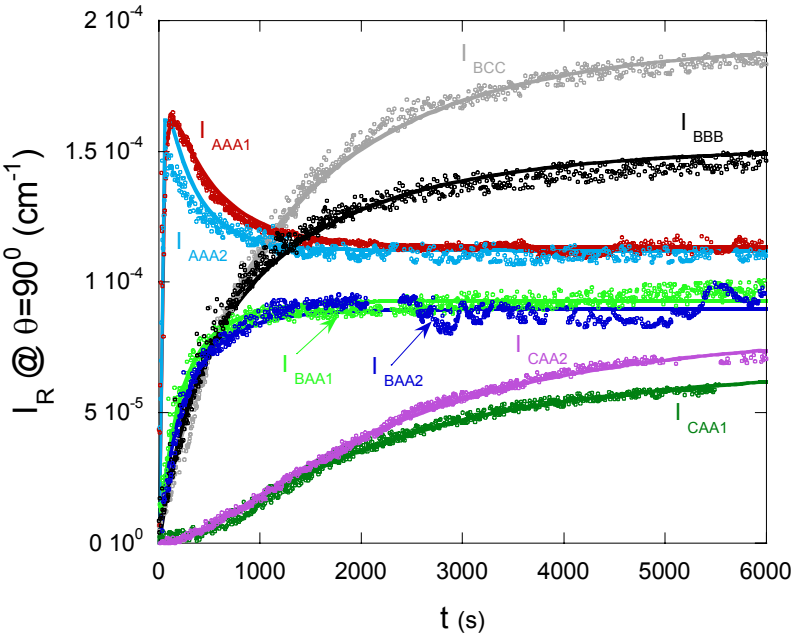


$$1/v = 1/v_{max} + K_m/cv_{max}$$



SMSLS has also been used to measure and analyze simultaneous polymerization reactions. Below are shown eight simultaneous acrylamide free radical polymerization reactions carried out with different reagent concentrations. Also shown are fits to the data according to the time dependent light scattering signatures we recently derived for the light scattered from polymerizing solutions. These permit estimates of M_w and the reaction rate constant for each reaction (not shown here), as well as any mechanistic features, such as the presence of impurities competing for free radicals.

(from M.F. Drenski, E. Mignard, A.M. Alb, W.F. Reed, "Simultaneous in Situ Monitoring of Parallel Polymerization Reactions using Light Scattering; a New Tool for High Throughput Screening", J. Combinatorial Chemistry, in press)



* W.F. Reed US Patent #6,618,144, "Device and method of simultaneously measuring the light scattering from multiple liquid samples containing polymers and/or colloids" 9/9/2003.

SMSLS literature

1. M.F. Drenski, W.F. Reed, "Simultaneous Multiple Sample Light Scattering (SMSLS)", Polymeric Materials: Science & Engineering, 88, 304-305, 2003

2. M.F. Drenski, W.F. Reed, "Simultaneous Multiple Sample Light Scattering for Characterization of Polymer Solutions", J. App. Polym. Sci., vol. 92, 2724-2732, 2004

3. Alina M. Alb, Emmanuel Mignard, Michael F. Drenski, and Wayne F. Reed "In Situ Time dependent signatures of light scattered from solutions undergoing polymerization reactions", Macromolecules, 37, 2578-2587, 2004

4. Michael F. Drenski, Emmanuel Mignard, Alina M. Alb, Wayne F. Reed, "Simultaneous in Situ Monitoring of Parallel Polymerization Reactions using Light Scattering; a New Tool for High Throughput Screening", J. Combinatorial Chemistry, in press