Holiday Greetings from Manning Applied Technology
December 2008

Happy Holidays to our customers, vendors, friends and colleagues. What an interesting year 2008 has been! As the New Year approaches, we take time to reflect on where we've been and where we might be going. We see a lot of good news in the intermediate- to long-term future.

Humans never before have possessed tools as powerful as the current generation of computers. Thus far, we have only scratched the surface of how to use them effectively. Aided by computers, biotechnology will vanquish many diseases in the years and decades ahead. Solar and nuclear power, with the use of computer-aided design and modeling, could provide a virtually inexhaustible supply of energy. No tool yet invented offers a greater prospect than computers for doing more with less, which adds value. MAT was founded to create and deliver value in the form of new knowledge, typically embodied in scientific instruments and R&D services. We strive to achieve world-class excellence and efficiency; inexpensive computers have been critical to our achievements, thus far.

MAT staff celebrate the 15th year of business...

with a balloon launch at a party.

I will touch only briefly on the headwinds facing the US and world economies. Their name is Legion, for they are many. Most can be read in the headlines or at least found in the back pages. In no particular order, they include: peak debt, peak oil, aging populations, looming shortages of critical skills, and an overvalued currency. The world was filled with mispricings that now are unwinding. Americans always can be counted on to do the right thing, after exhausting all of the other possibilities! [credit to Winston Churchill] We have just a few more options to cycle through before we decide to do things correctly.

With that segue back to good news, we consider the most valuable business concepts that we've learned in the past few years. Warren Buffett has stated clearly most of what we need to know to be successful. We start with Warren's quip, “If markets were always efficient, I'd be just another bum with a tin cup,” in which he teaches that any extraordinary return on investment (profit) is a result of market inefficiency. Derivation of the connection between monetary profit and Gibbs free energy is left as an exercise for the interested reader. Hint: all known life forms are non-equilibrium thermodynamic systems.

Warren has profited greatly from two levels of market inefficiencies, all of which are mispricings. Many are the result of the old emotions, fear and greed. At MAT, we are more interested by market inefficiencies that stem from lack of vision in applying technology. The first level of mispricings is in the capital markets, where future earnings occasionally can be purchased at a steep discount. Warren

said, “When I buy a dollar of future earnings for 50 cents, I feel like something good is going to happen to me.” Mispricings in the capital markets almost invariably are transient.

The second level of market inefficiency is in the markets for goods and services. Most of these market inefficiencies also are transient, often on a much longer timescale than those seen in the capital markets. Stock market lows rarely persist for more than a few months. Some small percentage of market inefficiencies persist for many decades, or even longer. Warren has done a masterful job of buying companies with persistently high profits. My favorite example of a very persistent market inefficiency is the premise that one flavor of sugar water is better than another. Since Warren Buffet bought Coca-Cola stock in the 1970's, it has made billions of dollars for him and his partners.

The last Buffett quote is the most important for small business: “If I were running $10 million [instead of $200 billion], I'd have no problem making 50% returns every year.” Mike Gross immediately grasped and articulated that market inefficiencies follow a power law, with far more small-scale opportunities than large-scale ones. “Opportunities” has been substituted for the term “market inefficiencies” here, but “mispricings” would be equally correct. The mispricings of megacap companies (*e.g.*, General Electric) usually are much smaller in percentage terms than the mispricings of microcap stocks. Berkshire Hathaway can't consider purchasing stock of companies earning less than $75 million per year. Thus, Warren Buffett is restricted from operating in the potentially most lucrative markets. The capital markets are just a reflection of the markets for goods and services, indicating that high profits (and risk) can be expected for niche markets. The number of highly profitable niches for small business are virtually inexhaustible. Of course, there is the matter of finding the right ones. If it were easy, everyone would do it.

Mike shows a visitor the photoacoustic gas analyzer project.

MAT staff hard at work.

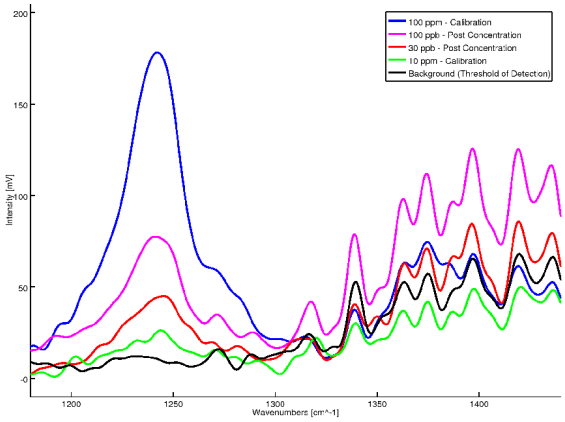
And that is precisely where MAT could have done better. The SBIR program is a brilliant government initiative aimed at addressing market inefficiencies with seed capital. MAT has been very successful in winning SBIR funding - and very successful in spending it. A significant portion of the funding has gone into training people, because the talent pool in Idaho for FT-IR spectrometer development work is remarkably shallow. It appears to be about four persons deep - three of whom work at MAT. Our best approach to finding the right opportunities is networking, which we have practiced diligently for many years. In fact, without successful networking, MAT would not be in business today. The results of several collaborations that resulted from networking appear below.

In recent years, powerful social networking tools have appeared. We encourage you to find us on LinkedIn here: http://www.linkedin.com/pub/a/b2/854 We also are active on Facebook here

http://www.facebook.com/profile.php?id=1523245647 A discussion of these and other software tools can be found here: http://techbriefing.blogspot.com/2008/12/first-cut-on-knowledge-management.html. MAT has two opt-in mailing lists; one provides commentary on recent technology developments and a second is a vehicle for Idaho technology companies to share information. The email list for this newsletter is opt-out. All can be accessed here: http://manningappliedtechnology.com/mailman/listinfo

Currently, MAT is completing a Phase II SBIR project under the DoD chemical-biological defense (CBD) program. A prototype gas analyzer based on FT-IR/photoacoustic spectrometry has been fabricated and shown to have a sensitivity in the range of 10 parts-per-billion for chemical vapors. The prospects are excellent for pushing the performance into the parts-per-trillion range. The novelty of the system is combining the real-time gas sensing capabilities of Fourier-transform infrared photoacoustic detection with sorbent preconcentration to achieve very useful detection limits.

Gas analyzer (interferometer removed for clarity).



Calibration graph showing 30 ppb detection limit.

In recent years, many other MAT projects have proved successful. Several customer/collaborator reports are included here (see below). The first is from Dr. Mike Anderson and Dr. Ralph Budwig at the University of Idaho, who report on acoustic particle sorting. This work was funded as a subcontract to a CBD STTR project for photoacoustic detection of bioaerosols. Dr. Michel Pézolet, of Université Laval, reports on work in his research group employing a fiber stretching apparatus built by MAT for the study of spider silk. Another update addresses MAT's patented disk-mirror interferometer technology. Dr. Tom Bitterwolf and Dr. Peter Griffiths have been using one prototype to study inorganic reactions. Dr. Don Pritchett of ATK/Mission Research reports on the successful demonstration of an air-bearing version.

We welcome the opportunity to work on more collaborative projects in the years ahead. The future of technology is very bright, especially if it can help us transition to new sources of energy, grow healthier food, cure disease and manage knowledge efficiently.

We wish you peace and prosperity in the New Year!

Sincerely,

Christopher Manning

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Acoustic particle size sorting
by Michael Anderson and Ralph Budwig
Mechanical Engineering Department, University of Idaho

It is a pleasure to report a breakthrough in acoustic particle size-sorting technology. Measurements obtained in a collaborative effort with MAT and the University of Idaho show that aerosol particle sorting is possible at air-speeds well above 1 meter per second. High power ultrasound is applied perpendicular to the flow of an airborne aerosol. Acoustic radiation forces act preferentially by particle size to redistribute the aerosol across the flow, as shown in Figure 1. An experimental measurement at the exit of the acoustic particle sorter is shown Figure 2. At the entrance of the acoustic sorting device, the aerosol was evenly distributed over the right hand side of the flow. Acoustic radiation pressure forces the particles to the left. A collection apparatus at the exit separated the stream into the collection bins labeled in color and by number. Manual counting of particles collected in each bin are totaled in

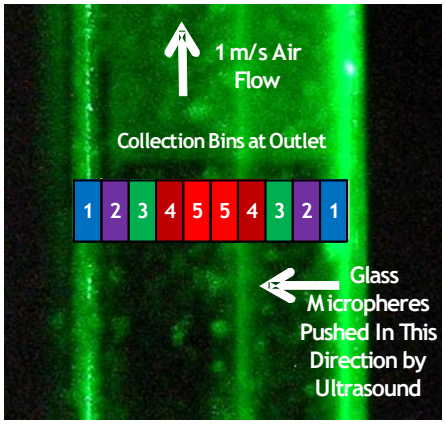

Figure 1: Laser illumination of particles in flow stream.

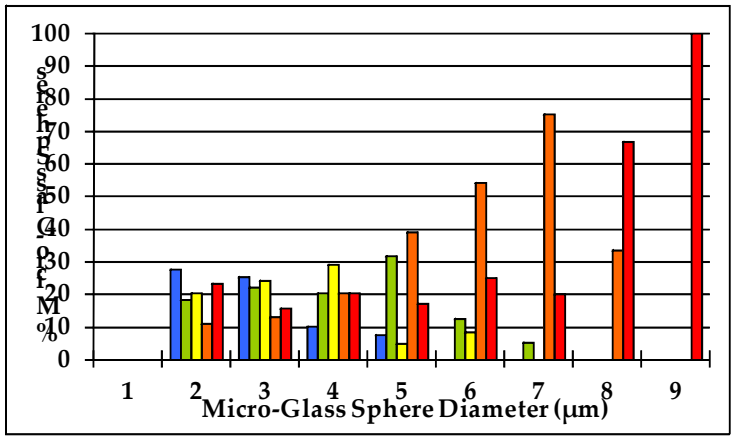

Figure 2: Experimental results showing particle counts in each bin.

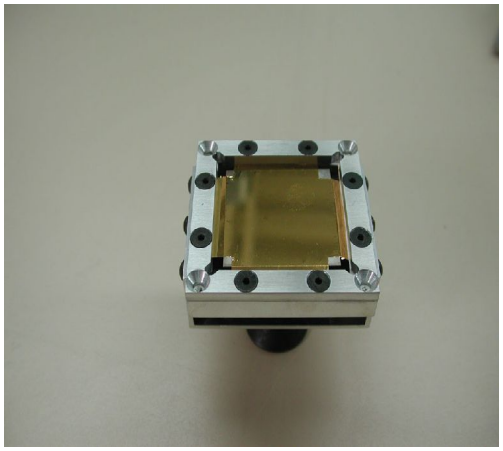
Figure 3: Micromachined ultrasonic transducer.

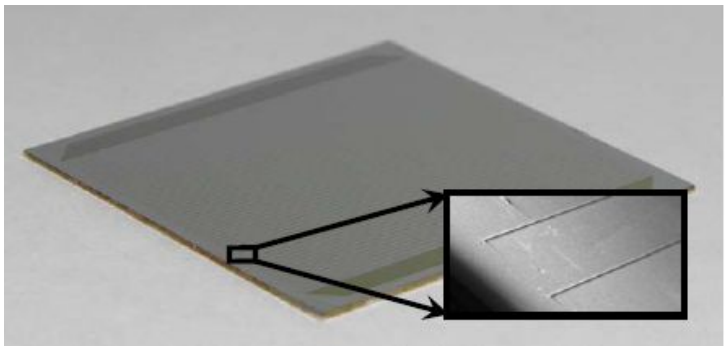
Figure 4: Detail of ridges separating membrane from substrate.

the graph in Figure 2. The majority of large particles were found at the middle of the exit cross section (bin 5) , while most of the small particles remained at the edge (bin 1). A crucial component of the apparatus is an electrostatic ultrasonic transducer, shown in Figure 3. This transducer utilizes a micromachined backplate, shown in Figure 4. Experience shows that this transducer provides a high power field, which enables rapid sorting. This effort may lead to methods for production of more

uniform industrial materials and improved biodefense capability.

Spectral measurements of drawn spider silk
by Michel Pézolet
Chemistry Department, Université Laval

Spider silk is among nature's highest performance structural materials, achieving, in some cases, combinations of strength and toughness that still are unmatched by any synthetic materials. Spiders produce several different silks, each with a specific range of mechanical properties. Dragline silk exhibits high toughness with a good trade-off between stiffness and extensibility. Such properties are due to the peculiar block copolymer structure of dragline silk that is composed of alternating alanine-rich hard segments, containing β-sheets, and soft segments rich in glycine. Raman spectromicroscopy is a powerful technique to investigate the conformation and orientation of proteins of different native

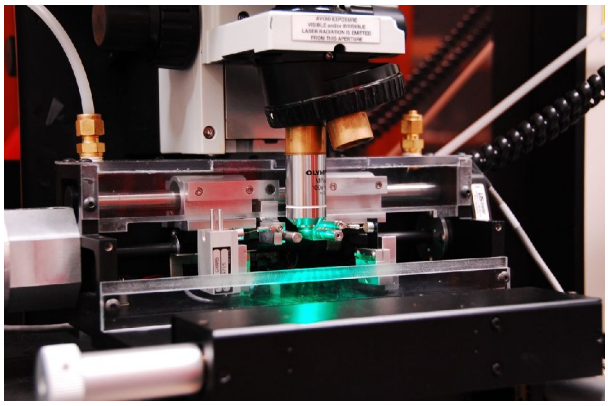

Figure 5: Fiber drawing apparatus manufactured by MAT.

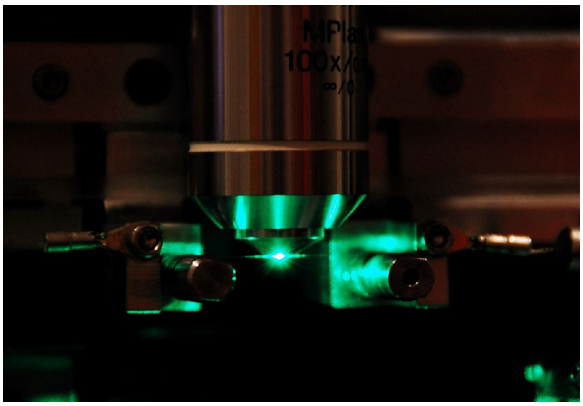

Figure 6: Fiber illuminated by green laser in Raman spectrometer.

silk fibers. The main advantage of this technique is that the laser beam can be focused to about 1 μm in diameter in the sample, therefore allowing the *in situ* recording of high quality spectra of single silk filaments.

Our laboratory has recently studied the effect of mechanical deformation on the polarized Raman spectra of single spider silk fibers using a fiber stretcher specially designed by MAT (Figure 5). This stretcher, that fits under the Raman microscope (as shown in Figure 6), allows the simultaneous recording of the Raman spectra and the stress and strain applied to a single fiber of about 5 μm diameter under controlled environmental conditions.

The double-screw mechanism of the apparatus allows the fiber to be deformed symmetrically such that the Raman spectra always are obtained from the same volume of fiber during the course of deformation. Figure 7 shows a typical stress-strain obtained for a *N. clavipes* dragline fiber stretched at a strain rate of 1% s^{-1} in 60% relative humidity. The stretching was stopped for 4 minutes at 20, 25 and

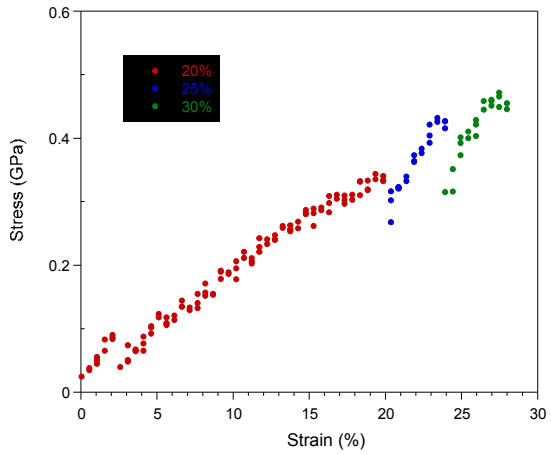

Figure 7: Stress-strain curve measured with the use of fiber drawing apparatus.

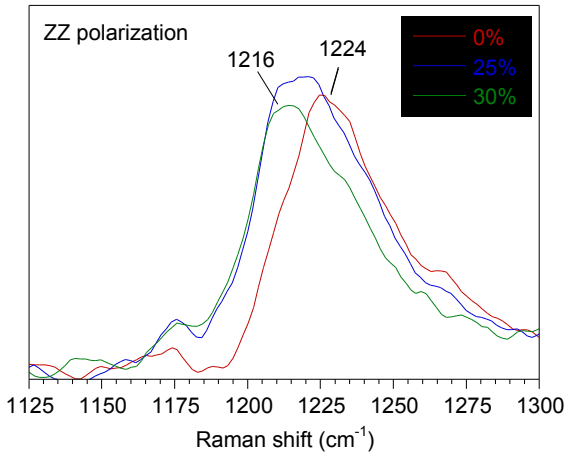

Figure 8: Spectral changes induced by deformation.

30% elongation to allow recording of the polarized Raman spectra. Figure 8 shows that the amide III band, which is mainly associated to the C-N stretching vibration of the peptide group, shifts by approximately 6 cm^{-1} during mechanical deformation. On the other hand, the frequency of the stretching vibration of the C=O groups (amide I vibration, not shown) is not affected by the stress applied to the fiber. Since the protein chains predominantly are oriented along the fiber axis, our results suggest that the applied stress induces a weakening of the amide C-N and C-C groups without any significant effect on the chain orientation. Different types of silk fibers and the effect of the relative humidity are currently under investigation. This effort may lead to improved engineered and bioengineered polymer materials.

Prototype disk-mirror interferometer
by Don Pritchett
ATK-Mission Research

Under license from Manning Applied Technology (MAT), Alliant Techsystems, Inc. (ATK) has fabricated a rotating mirror (aka disk-mirror) interferometric spectrometer that can measure 1000 spectra per second at 4 cm^{-1} resolution. The project is called HyHATS, for the Hypertemporal-Hyperspectral Analysis Test Station. The ATK design, shown in Figure 9, built on the fundamental concepts that MAT patented, with a modification to achieve a more compact layout. The mirror arrangement minimizes the number of bounces in the cube corner allowing relaxed specifications for orthogonality and wavefront error.

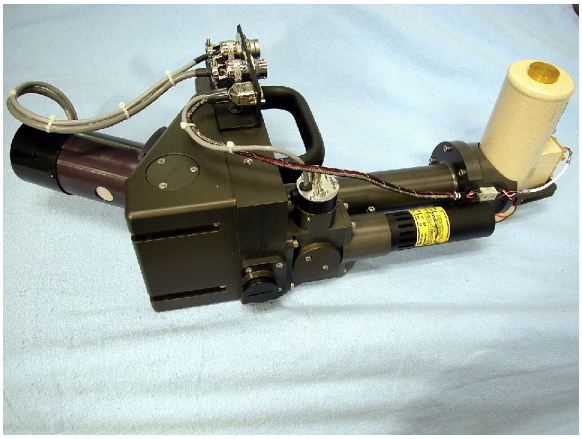

Figure 9: ATK prototype disk-mirror spectrometer.

The spectrometer that ATK has developed is useful for measurements relevant to their core business areas, which include rockets, explosives and special sensors. Many rocket engines exhibit spectral variations in the millisecond range. Understanding the chemistry and evolution of reaction products requires very fast, relatively high resolution spectral data to be collected, preferably remotely. The new capability is sufficient to record many unique signatures. No commercial instrument can approach these specifications presently. The objective of the current HyHATS effort is to study applications of the new instrument.

A spectrometer that approaches specifications of the HyHATS design is being operated for chemical measurements in the University of Idaho Chemistry Department. The laboratory spectrometer was designed, fabricated and patented by MAT. It is this fundamental design that has been updated by ATK to an air-bearing support, with higher-speed electronics to fully support the rate of 1000 spectra per second. The existing hardware indicates that the system is very stable, with negligible movement-induced noise over the whole temporal bandwidth of operation, from a few to 300 spectra per second and over a spectral band pass that extends to 25 microns. This effort has resulted in substantially improved spectral measurement capabilities.

the area around Troy in summer

Spring Valley Reservoir in winter

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