

Insight

A regular update to the semiconductor industry



July 2007

The new face of Epichem Group News

SAFC Hitech

Perfectly Positioned For Further Growth and Leadership in the Electronic Chemicals Market

July 2007 is a milestone month for SAFC Hitech™ as it sees the unveiling of the division's new identity following the acquisition of Epichem, a deal which, in many ways, effectively completed the Hitech jigsaw, and rounded off the company's overall business proposition for the next phase of growth and development.



The integration of Epichem's expert understanding of advanced chemistries for the silicon and compound semiconductor markets, and industry relationships, combined with SAFC Hitech's existing understanding of manufacturing production-scale high-purity chemicals, its global supply chain infrastructure and financial strength, means that the new entity now offers something very unique: customer access to chemicals expertise, close collaboration on the development of new materials and process integration schemes, and the ability to quickly scale-up to volume production levels. This business model accelerates technology progression and time-to-market, giving the company a strong competitive edge in the semiconductor industry.

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| Enabling Technology

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The role of chemistry in semiconductor manufacturing is rapidly evolving as the industry strives to keep pace with Moore's Law. The rapid acceleration of technology in the electronics industry, along with the explosion of consumer electronics in emerging markets, are driving the demand for ever-increasing and faster performance from electronic devices. This need for increased performance and smaller design rules brings greater complexity in device manufacturing, especially on the gate level where molecular chemistry is being applied. Going forward, OEMs, chemicals companies and IDMs will need to interface directly with each other to develop the best chemistries, process technologies and integration schemes for particular applications.

Innovation in materials, and process chemistries in particular, have become critical to the continuing, successful evolution of the electronics industry, and tier one customers worldwide are looking to SAFC Hitech to be at the forefront of advances in the electronic materials and chemicals used in the manufacturing processes at the silicon and compound level. As specialists in chemical and molecular development, SAFC Hitech is focused on capitalizing on the market opportunity presented by this change in importance of chemistry in electronics and semiconductor manufacturing processes.



SAFC Hitech,
President
Barry Lease

Talking about the new SAFC Hitech, division President Barry Lease had these words: "As we continue to find innovative materials for next generation technology nodes, the need for greater collaboration between process engineers, tool manufacturers and chemical companies becomes critical. What we will experience moving forward is an increased commitment to a turnkey approach through increasing levels of cooperation. This signals a change in the traditional business model. SAFC Hitech is well positioned to capitalize on this market opportunity, guiding customers successfully through the entire supply chain and production process, from R&D through pilot production to commercialization and materials disposal."

New Company Identity

To communicate the new corporate identity ethos, capabilities and product portfolio to existing and potential customers, the company is undertaking an ambitious worldwide marketing communications, advertising and PR campaign, proactively engaging the global media and technology analysts.



This campaign will outline the segment unique business proposition - offering a total supply chain partner capability with global sales and local service to deliver market leading chemicals expertise to the silicon and compound semiconductor industries.

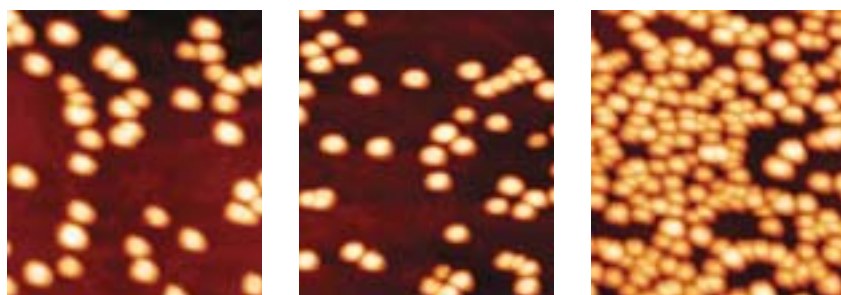


InN Quantum Dot Progress

The EU supported project INDOT began in 2006 to study the MOCVD of InN nanoparticles suitable for light emission in the 1.3 - 1.55 micron region with SAFC Hitech, SAES, Aixtron and Montpellier University as partners.

At that time a number of issues had to be overcome requiring new precursors, new gas purifiers and new equipment configurations. In particular the necessity of growth at less than 700°C in a non hydrogen ambient had to be solved. A number of precursors have been assessed, particularly N sources other than NH₃, along with different carrier gases to achieve controlled growth of InN QDs on GaN. The results are shown in the Figure below.

The impact of the change in carrier gas is significant and offers a method for tailoring deposition processes according to density requirements. The next stage is to cap the InN dots with GaN without destroying them thus low temperature GaN deposition is needed. Initial results using alternative sources have demonstrated GaN layers grown at temperatures as low as 600°C exhibiting a promising crystalline quality (fwhm=1690 arc-secs). This is better than that obtained using ammonia (about 3560 arcsec).



a) Helium

b) Nitrogen

c) Argon

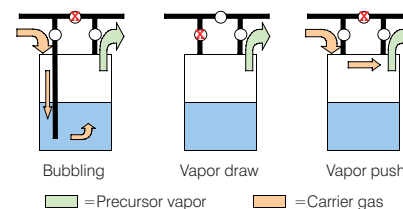
AFM images of uncapped 20 nm high InN dots grown under the same growth conditions on GaN, but with different carrier gases. The surface densities are respectively 1x10⁹ cm⁻², 1.5x10⁹ cm⁻², and 7x10⁹ cm⁻²

For full details of the project please visit its website
<https://www.indot-project.net/index.html>

Optimizing Precursor Delivery

Ongoing research into thin film deposition processes and precursor development for atomic layer deposition (ALD) of oxides and nitrides continues to highlight novel materials. However, due to their complex molecular design, volatility can be low making chemical introduction to the vapor phase problematic. To achieve sufficient vapor transport high bottle temperatures must be employed leading to potential degradation of the precursor with use. At Liverpool investigations into different methods of precursor delivery have recently begun. In particular comparisons between thermal vapor draw and carrier gas introduction approaches were targeted.

In vapor draw, the precursor is simply heated in a bottle to produce vapor, which can be "sucked" off the top when opened to the reactor system vacuum. Bubbling gas through or over the precursor not only increases the surface area between the gas and the precursor, hence enhancing vapor pickup, but also acts as a carrier gas, which helps to reduce gas stagnation.



For this initial study, TiO₂ films on Si(100) were deposited via ALD using Ti(OPri)₄ and water vapor. The ALD cycle used 0.1s precursor doses, followed by 5s gas purges. The precursor was heated to 70°C in the precursor bottle and tests of deposition rate carried out using each of the three bottle configurations.

TiO₂ films on Si(100)



Bubbling

Vapor draw

Vapor push

The results highlight distinct differences in deposition rate with little or no growth using vapor draw (0.03nm/cycle), increased growth with vapor push (0.08nm/cycle) and the thickest films with bubbling (0.10nm/cycle). For controlled deposition of improved quality films the vapor push appears most promising however further work is required to confirm results and optimize transport conditions.

For further details contact Dr Richard Potter
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SAFC Hitech and memsstar®

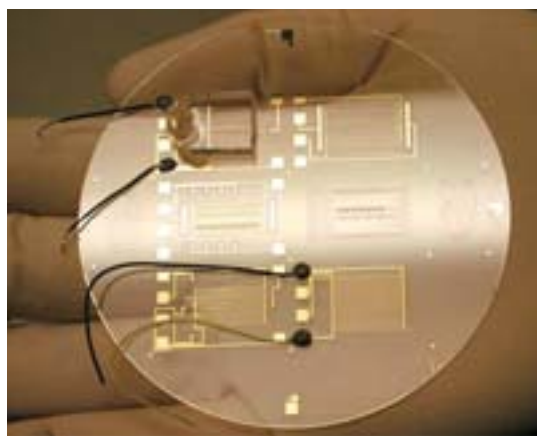
Technology Form Strategic Alliance for MEMS and Nano Materials Coatings

To better service the emerging technology needs of companies involved with MEMS and nanotechnology devices, SAFC Hitech and memsstar® Technology have joined forces to supply fully qualified systems and materials for Surface Coatings on micro devices. More and more nanotechnology devices are being developed and entering the mainstream as investments into nanotechnology research and related products rise. Increasingly these devices include an ultra thin coating deposited on the surface to enhance device performance and/or reliability. The proprietary memsstar® vapor phase systems offer customers more robust films and shorter process times, together with more environmentally friendly methods compared to liquid processing.

Example applications include microfluidics where it is important to ensure hydrophobic or hydrophilic surface properties for devices such as inkjet heads or microneedles, or medical applications where bio-compatibility is essential. Other applications include moisture barriers and moving micro-sensors where anti-stiction properties are essential. The memsstar® SPD (Surface Preparation and Deposition) systems offer an integrated process capability to fabricate and modify devices on the same tool. Customers can now quickly and easily implement a full process solution using fully qualified materials backed up by total support from the strategic alliance.

Both SAFC Hitech and memsstar® Technology are committed to helping the cost effective development of new devices and technologies by their customers.

For details of the memsstar® SPD system visit <http://www.memsstar.com/> or contact Mike Leavy mike_leavy@pt35.com



EuroAsia Semiconductor Award Nominations

SAFC Hitech is proud to announce that it has been short listed for two awards in this prestigious competition. Both are related to its excellent precursor development program and highlight the world leading standards and collaboration strength in this area. The first nomination (Materials) relates to the development of novel Hf and Zr precursors for improved performance in ALD of high-K dielectric layers whilst the second (R&D Initiative) covers relationships with leading Universities and the network of groups involved to further source design, synthesis, characterization and performance.

For full details and to ensure your vote counts visit <http://www.euroasiasemiconductor.com/productpreview2007.php>



Bubbler Milestones

The humble container used to store, ship and allow the ultra-high purity chemicals made by SAFC Hitech to be used efficiently has been the focus of much attention in recent years.

Primarily the methods required to re-cycle and re-use bubblers have been developed with the same painstaking attention to detail applied to the precursor fabrication and purification to ensure contamination introduction is eliminated.

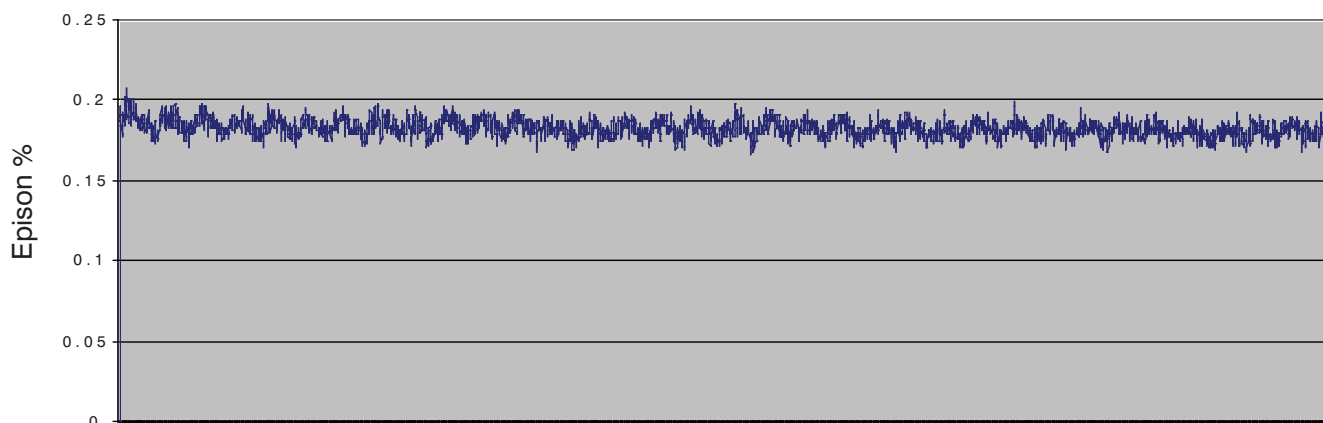
Once a rarity, the re-use of ampoules is now common and of the 25000 vessels SAFC Hitech have put into service over 5000 have been returned, treated, refilled and dispatched at least once. The record is held by a TMGa bubbler that has been through the cycle 12 times and is still going strong.



MgCp₂ bubbler pickup test using Epison[®]

SAFC Hitech's new bubbler designs for solid precursors has been extended to dopant sources where long term stability and reproducibility are of key importance. The delivery of highly controlled doses requires uniform transport and in-house testing with vapor concentration measurement equipment under user conditions has been performed. The results for Cp₂Mg demonstrate excellent output stability, well within the limitations of the system itself.

EP360 - MgCp₂ @ 100sccm, 50c, 200Torr



For further details contact a member of the SAFC Hitech technical team.

SAFC Hitech Supports Education at Science, Industry and Enterprise Week

This years Science, Industry and Enterprise week had the objective of promoting science in a fun way via 'hands on' displays and events.

The venue was the Catalyst Museum, Widnes, UK and support by North West Science Industries included the SAFC Hitech booth comprising bubblers, wafers, ingots of metal, EpiSensors™ and several photographs of SAFC Hitech personnel carrying out their jobs around the site.

Four schools attended the week with pupils from years 7, 8 and 9 (age 11-14yrs).

The pupils were taught how the electronics in their mobile phones and CD players were made and how relevant SAFC Hitech's Industry is to everyday life. The processes were explained from the ingot of metal right through to a 'chip' via a wafer. The safety side of SAFC Hitech was heavily promoted alongside the excellent opportunities for scientists in the workplace.

Handling bubblers and seeing wafers made them think about how technology is evolving at an incredible pace.

SAFC Hitech personnel 'manning' the stand had to be on the ball as the pupils had lots of interesting questions to ask – why do all the metals you use end in ium? Where do the metals come from? Can I sell the ingot on 'E-bay'?

The week was a great opportunity to see how youngsters view science and on the whole it is in a positive way as they recognize there isn't a job in the real world that doesn't involve science to some extent, however, remote the connection seems.



And finally the comment of the week has to be **“Aliens crashed on Earth and brought all the Technology with them!!!”**

For full details visit us at <http://www.catalyst.org.uk/download/Education/Ed%20Prog%202006%20both.pdf>

Transition Metal Nitride CVD and ALD Precursors

Introduction

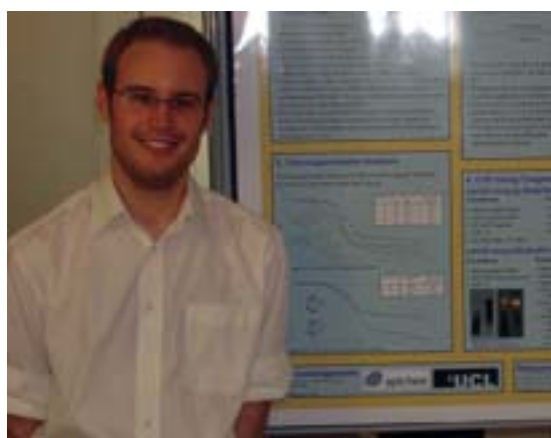
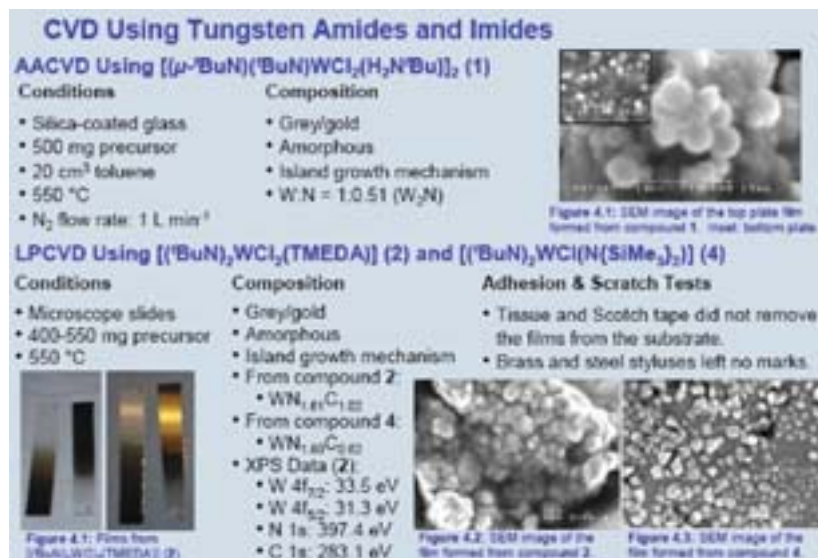
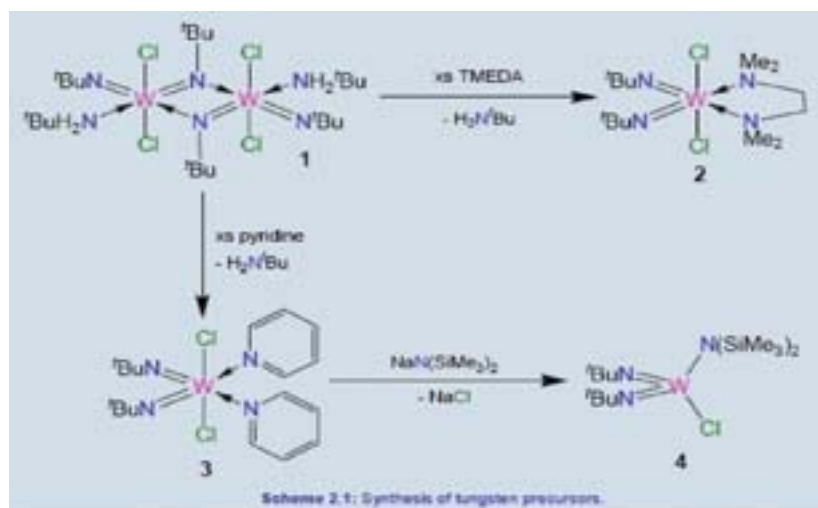
The metallic conductivity and refractory stability of transition metal nitrides makes them the materials of choice for diffusion barriers in various metallization structures of advanced microelectronic devices. Precursors with suitable deposition chemistry and appropriate physical properties are required for the successful deposition of these materials and whilst TiN and TaN have solutions, the source compounds for WN_x are more limited. The objective of this work was to investigate new chemicals for their suitability to CVD and ALD techniques and so physical properties of the precursors as well as their deposition capabilities were studied.

Synthesis

The complexes (2-4) have been synthesized from the mixed amido imido chloride precursor (1) via the elimination of $tBuNH_2$ and substitution of different ligands. (See Scheme 2.1) In all cases there are direct metal-nitrogen bonds to facilitate WN_x formation on the substrate.

Deposition

Tungsten imido and amido complexes 1, 2 and 4 deposited adhesive, amorphous W_2N , $WN_{1.6}C$ and $WN_{1.8}C_{0.6}$ films respectively.



Notes

The work detailed in this article was performed by Stephen Potts (pictured left) as part of his SAFC Hitech - sponsored PhD studies at University College London Chemistry Department under the supervision of Dr Claire Carmalt.

A poster presented at a recent UCL workshop by Stephen was awarded the "best inorganic poster" prize.

The high quality of the work reflects SAFC Hitech's policy to work with world leading groups across a wide range of chemical areas to provide the precursors needed now and in the future.

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