Dateline Sanibel, Fort Myers

On April 2nd 1995, the seventh bienniel workshop on Organometallic Vapor Phase Epitaxy opened under fine, fair Floridian skies in the elegant Sanibel Harbor Resort. In some ways this beautiful resort location resembles the Hotel del Coronado in San Diego – a younger Hotel Del, plus towers, but without a 'real beach'. Thus, it creates the modern Victorian-style hotel description in the 'much revered' AAA directory. Judging from a fair sampling and from other comments, the resort facilities and cuisine were well appreciated, especially the food provided by the various sponsors. However, not one attendee could recall a 'sports bar' that closed at 10.00pm for any reason. So, for most patrons it became a 'spoil-sports bar'!

This workshop has always been organized for and by the American MOVPE audience but the approximately 190 attendees from 12 countries provided the conference with a representative cross-section from the worldwide MOCVD research community and from its equipment and materials suppliers. The workshop also doubled-up as a location for company sponsored equipment-users meetings, one each by AIXTRON and Emcore.

The TMS (Minerals, Metals and Minerals Society) staff provided a pleasant and well run conference and they were duly recognised at the banquet, having laid the foundation for the real upbeat mood that appeared to emanate from the whole conference, with every segment appearing to ooze confidence; equipment and materials suppliers, researchers and manufacturers alike. Was this phenomenon driven by organic epitaxial dreams of new blue diode pathways to LEDs and lasers, orange and red tail lights, longer wavelength infrared communications lasers, all lighting up the MOCVD way to higher volumes of III-V alloy based products? Surely the answer is yes. Thanks to the last fifteen years of MOCVD research, the future is looking ever brighter! And, compound semiconductors could again be poised to break into large new market segments with MOCVD reactor capacities now as high as 95x2" wafers (or 20x4" and 9x6") available from AIXTRON.

A new format for poster papers was tried for this conference, whereby all authors were asked to provide a three minute oral presentation of their paper in a separate session, followed by the usual on-location discussions. After what appeared to be much pre-consternation by most authors, the mini-presentations went quite smoothly and were well received. Perhaps next time four minute presentations could be allowed, with a coffee break at mid-session.

Noteworthy note at this conference was the degree to which industry sponsors provided support to official events, in addition to putting on their own customer appreciation programs. Sponsorships ranged from the provision by Emcore of a haven for UCLA fans (and a few alumni) to see the UCLA team attain the pinnacle of NCAA basketball by beating Arkansas – to the sponsorship of the Sunday welcoming reception (and morning coffee) by AIXTRON – and the hosting of the pre-banquet reception by Morton. An additional sponsorship program worthy of mention, was the behind-the-scenes provision of money to students to enable them to attend this conference. (I wish such deals were around when I was a grant-in-aid student – how times have changed).

The number of exhibitors was small by most conference standards, but very focused. The materials exhibitors were Air Products, Akzo, Epichem, Morton and Solkatronic for MOCVD process chemicals and precursors – MCP and Nimtec for substrate wafers – Epitaxial Products International for epitaxially layered device wafers – Rockwell for MOCVD-based devices and systems. Support equipment for process measuring and monitoring were exhibited by MKS Instruments and Thomas Swan.

In keeping with recent developments in this industrial segment, the III-V flavour of the month for this conference was gallium nitride (GaN).

Since the announcements by the Japanese companies of the successful production by vapour phase epitaxy of GaN-based blue-green emitters, participants in the MOCVD community, both research and industrial, have been investing heavily in new capacity and capability.

The deposition equipment manufacturers exhibiting at the workshop, AIXTRON, Emcore and Thomas Swan were offering their latest MOCVD layer deposition systems. All were promoting equipment designed to improve the output and quality of gallium nitride growth processes, including an improved GaN reactor head design shown by Thomas Swan. In conjunction with 'the improved chemical sources being offered' these engineering combinations 'must of course' lead in turn to better and more reliable GaN-based LED and laser devices. In the future, wafer production for GaN devices could also become easier using the AIXTRON 7x2" reactor reported in the Poster Session. This reactor, described in the paper "New III-Nitride Alloy Heterostructures for Optical Devices Grown by MOCVD", is claimed to be the largest GaN reactor available and offers layer growth temperatures as high as 1500°C.

The growth of indium antimonide materials also received considerable attention at this conference. The main focus of the antimonide investigations reported here was the growth of a wider range of ternary and quaternary alloy strained-layer superlattice compositions. These layer structures are needed for the production of commercial InSb-alloy devices that emit in the 2 to 5 μm wavelength range, especially for the production of effective lasers operating at the 2.5 μm wavelength and 'far out' devices working at the 12μ wavelength to solve a special interest need. Stepped up interest in antimonide lasers has also led to an increased interest in new and higher purity antimony precursors, for example, layer growth using trisdiethylamine antimony was reported (see previous issue of TFR). State of the art large scale InSb epilayer production was presented in a paper by Hughes workers who described the use of an AIXTRON 8x3" Planetary Reactor for the high yield production of magnetic resistive sensors for automobile applications.

The incorporation of high levels of oxygen in aluminium containing III-V epitaxial layers grown by MOCVD and CBE layer growth processes has long been a potential problem for the device makers due to the creation of deep level centres. Papers presented here reported incorporated oxygen levels as slow as $5x10^{16}cm^{-3}$. In the case of the DRA at Malvern, UK, the reduction was obtained by the use of 'low oxygen' precursors in which the diethyl ether content, often present in metal alkyl sources, had been eliminated by the use of solvent systems that do not use oxygen-containing ethers. Oxygen scavenging methods of removing ethers were also described.

In a lighter vein – the workshop location and facilities (sport, natural wild life refuges, the Everglades) were very conducive for leisure time use. Two historical items, unique to this area, were the side-by-side winter homes of Thomas Edison and Henry Ford, so located because of their lifelong friendship. These amenities and pastimes were appreciated by the visitors and supported by the local weather until the last night's washout. They included boat rides (sponsored by Air Products, Emcore, Epichem), kayaking and jet-skiing sponsored by AIXTRON, golfing, tennis, nature studies of all types, swimming and of course the perennial pastimes of eating and drinking plus other body punishing sports.

Unfortunately for some of the local inhabitants, the sporting skills of our highly technical colleagues must not have been too high, since it was reported that the diet for many local species of fish had temporarily changed to golf balls. Twas overheard that some attendees were hoping that this location was really the home of Myers Rum, but reality prevailed and they went home perhaps a little disappointed. Brits were really made to feel at home with Bass Ale on tap and Ty Naut as the house mineral water.

The final technical event, the banquet, followed the apprehensions of the new poster format, but most were mellowed by Morton-hosted cocktails. The dinner was well attended and the chairman, Dick Lum, and his committee members were able to scrutinize the plebs from their elevated table(!) and pick on a few poor unsuspecting audience members during the proceedings. The chairman indicated to all what was going to happen at future meetings as the audience willingly devoured their food and libations. The past committee was thanked and rewarded for organizing this 1995 meeting and the chair introduced the speaker, Professor Dan Dapkus from USC. Dan is such a revered old member of the MOCVD community that his talk was preceeded by a lively song and

AIX 3000 Multiwafer Planetary Reactor.

dance cabaret event presented by the international troupe of MOCVD girls (in drag) "The Terry Lovis Dancers".

Dan has the perfect background as a dinner speaker on the topic of MOCVD. His early career started at AT&T Bell Labs without metal organics – then left nirvana (to the amazement of his fellow employees) to join Rockwell in the primeval days of MOCVD layer growth (they said it would never work) – and finally slid into a Professorial Chair (of retirement?) at USC to pass on his invaluable experience to his students; the MOCVD scientists of tomorrow! Those were the days when it really was MOCVD not OMVPE, since many of the deposited films and layers were not epitaxial!

During his talk he recalled how his AT&T supervisors said that MOCVD did not stand a chance and that not one could believe that he would leave the hallowed halls of AT&T Labs for California to work for Rockwell International. However, as time would tell, he was going to be working with the **real** pioneers, Hal Manesevit and colleagues. Dan also related how difficult it was in the beginning to get funding, DARPA wanted devices, but devices needed months or years of process development – more ingenuity was required for the preparation of proposals than for the lab work!

Dan had delved into various archival sources, pulling out photo's of the original lab, the equipment and one of the early Rockwell group pictures, most of those in the picture were still in the industry today (apart from a few with professorial titles!) and quite a few were present at the meeting – fortunately still believers. Finally, Dick Lum closed the event and conference-goers sought places to continue their festivities, before attending the last papers and then having to find their respective paths home.

At the time of writing the location for the next meeting in 1997 had not been selected. But, avid addicts of MOCVD technology can receive their next fix by attending the EWMOVPE VI, the European MOCVD Workshop to be held in Gent, Belgium June 25th to 28th 1995. Hope to see you there.

That's the way it was in Sanibel, Florida, April 1995.

Dr. GAAS

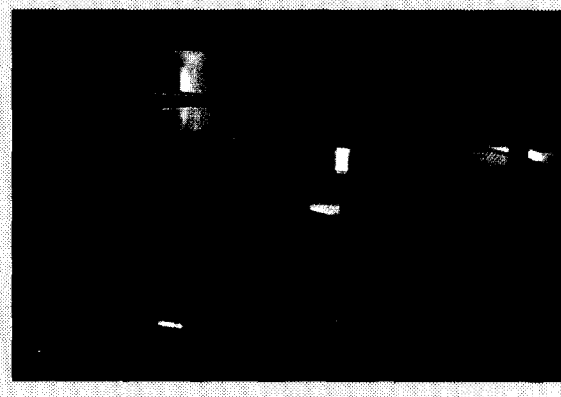
New Planetary Reactor for Gallium Nitride Production

Over three years of development, research and industry cooperation has led to AIXTRON becoming "Industry Leader" in the field of GaN wafer production equipment. The new AIX 2000 HT model has a capacity of 7 x2" wafers and a temperature capability in excess of 1500°C. "As such it is the most advanced equipment on the market. Commercial processes and production volumes of blue and green GaN based emitters are now being developed around this reactor design, says AIXTRON.

The market-need for this equipment is the production of blue/green LEDs and the development of the as yet elusive GaN-based laser. Such devices require the growth of GaN, AlGaN and InGaN alloy layers.

Gas Foil Rotation of the wafers and the radial 2-flow design have been optimized by computer simulation to give excellent uniformity over the whole 7 x 2" wafer growth area. A next generation system is already being developed with an 11 x 2" wafer capacity.

To incorporate the high temperature rating of 1500°C needed for growth on silicon carbide, the system includes powerful multi-coil heating. The combined features of very rapid heating and cooling for growth initiation on Sapphire substrates and p-doping, fast gas switching and in-situ cleaning provide a quantum leap in nitride growth technology.



AIX 2400 HT Multiwafer Planetary Reactor.