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Frequency Matters.

Marc Rocchi, President of OMMIC Perspective

In Conversation with Microwave Journal

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OMMIC is a supplier of MMIC circuits, foundry service and epitaxial wafers based on III-V (GaAs, GaN and InP) materials. As a leader in advanced technologies, the company provides its customers with cutting edge performance for telecommunication, space, instrumentation, avionics, security and defence applications. The state-of-the-art technologies include mixed mode E/D PHEMT, low noise and power PHEMT, metamorphic HEMT , InP DHBT and GaN/Si HEMT , enabling the design of a wide range of MMICs including LNAs from 900 MHz to 300 GHz, highly integrated T/R functions and millimetre-wave power amplifiers.OMMIC offers standard products as well as custom designs and has a long history of providing foundry services with complete design kits, training and design assistance. Hermetic and plastic packaging, test and qualification (including space and military) are also offered, with OMMIC's principal markets being in cellular communications, high data rate links, phased array antennas, millimetre-wave sensors, HiRel devices for space and defence and foundry services.

In conversation with Microwave Journal Marc Rocchi, OMMIC's President offers an insight into the company's operation, strategy and future plans.

OMMIC specializes in III-V semiconductor technology, supplying GaAs, InP and GaN solutions up to 300 GHz. Rocchi begins by explaining the company's approach to each solution – for GaAs it is mainly PHEMT and metamorphic, for InP it is HBT, while GaN is on silicon with a HEMT solution.

He states, "We take a scaling down approach, going from 100 nm to 70 nm to 40 nm for GaAs, and for GaN it is exactly the same story. It is a question of scaling the material – basically making the heterojunction thinner and scaling the gate or emitter sizes of the transistors. For InP – that's the HBT emitter, scaling is from 1 micron to 0.5 microns and later down to 0.2 microns."

Rocchi continues: "To push the boundaries we have two main targets: On the receiver side it is to improve the noise figure and linearity performance and on the emitter side the aim is to improve the dynamic range and the power and power added efficiency at very high frequencies.

"What I want to stress immediately is that it all depends on the application. Each application has a very specific requirement and there is not a single roadmap that is perfectly suited to all applications. And don't forget we are mainly dealing with very high frequencies – from 20 to 300 GHz and reasonable power – up to 20 W."

He goes on to explain: “There are two dimensions – the feature side and the material, which have to be adjusted. For that we control the material, which is part of our strategy. We buy materials from time to time but mostly we develop the material ourselves.”

Rocchi personally contributes to the development and evolution of the International Technology Roadmap for Semiconductors (ITRS), which OMMIC adheres to. Behind this strategy is the firm belief that roadmapping is not just something that belongs to Silicon. He comments, “People rarely speak about roadmapping for III-V technology but we must. Some don’t believe that there is the justification for spending so much money on new processes for the future because the market is so small.

“However, when I was in Asia recently it was clear that the system guys are keen to achieve ever higher performance at the system level. For that you need higher breakdown, lower noise and so forth, requiring continuous improvement. I have the firm belief that the market requires advanced roadmapping in III-V, not only silicon.”

Rocchi elaborates; “Silicon is mainly dictated by digital roadmapping while in III-V’s we are ready to change the starting material while scaling the sizes as much as we need. So, we are controlling the roadmap totally because the system specifications vary and require it. It is not just a question of scaling; it is related to system demand.”

Explaining the company’s philosophy he states, “What is interesting is that above 100 GHz most companies in the world are R&D centres – captive or not, private or not. We are one of the very rare companies working at such high frequencies on an industrial scale. We are not interested in big markets but concentrate on reasonable sized markets where there are good margins and the price pressure is not as acute as it is at the lower end of the market.”

Rocchi acknowledges the inroads that CMOS has made, particularly in the cellular PA sector and accepts that it is impacting on GaAs. He says, “I believe GaAs is a niche technology. Some people consider that if you don’t address large volume applications it is a disaster and that if you don’t get big you cannot develop the technology. I don’t believe that is true.

“For cellular phones GaAs still has a role to play but it is not moving fast enough and has not improved a lot recently, which is why I think CMOS will catch up. I firmly believe that if someone had tried to improve the PAE by going for instance to an InP HBT PA instead of a GaAs HBT PA they could have possibly reached 70% PAE in the saturated mode . They have not done that but have stuck with GaAs, so the difference between CMOS and GaAs is getting closer and closer.”

He concludes, “The main thing is that if you don’t keep moving you are dead! CMOS is doing wonderful things and I don’t think there are big volume opportunities for GaAs.”

As Rocchi has pointed out OMMIC is primarily focused on the professional sector of the market, which is mainly telecom infrastructure, space, instrumentation, automotive, security, defence and avionics. He explains, “In all these systems there is a need for linearity, power level and noise figure, all at the same time. To get all these three things at the same time is why you need GaAs or III-V in general.

“If you need to meet only one of those criteria you can do it with Silicon. If you take all of the specifications required by customers together you need to have a technology that offers flexibility, together with the dynamic range and noise figure. All together these things are the decorrelation of the cut-off frequency with the breakdown voltage, which is what we have achieved with GaAs and even better with GaN, with respect to Silicon.

“You go up in frequency but at the same time you keep the breakdown voltage, as well as the linearity, and

that is essential. And, very surprisingly, systems people who do not care about the technology are developing more and more demanding systems in terms of the specs."

He continues: "To give an example we are developing chip sets at 90 GHz and above for telecommunication infrastructure. This illustrates the fact that people are not just working at 60 GHz but up to 120 GHz on telecom systems – point-to-point and point-to-multipoint. System requirements are moving extremely fast and Silicon cannot always dictate its role!

"All the system guys would like to be using Silicon but they are coming to III-V because they have no choice as Silicon can't meet all the specs. If you take telecom, the primary requirements are linearity and power but linearity is particularly important because of digital modulation. And, for space the volume is very low and the entrance cost is too high so the Silicon guys aren't interested. Instrumentation is like telecom with the same requirements but with the emphasis being on wideband. Security requires very specific components. We have developed a tunnel diode at 100 GHz, which is antimonide based, zero-biased and temperature independent, which we presented at EDI CON 2013 in Beijing. This is a good example of a very specific medium volume component where Silicon cannot compete.

"Defence applications are really greedy for power at high frequencies – above 20 GHz. For avionics we have smart antennas, electronically steerable antennas with core chips and we have been able to prove that we can achieve some level of integration."

Rocchi sums up the company's philosophy when he says, "OMMIC is trying to deliver an innovative approach in terms of integration of digital and analogue function on the same chip. It is not Silicon but it is good enough to offer big improvements for the system people."

Considering the capabilities available in the company's most advanced processes that have recently come to the fore Rocchi explains, "For the 70 nm process we have gone from early introduction to real production. That is important because we cover extremely low noise from L-band to W-Band.

"On the power side OMMIC has been catching up. Now, we have a 0.1 micron PHEMT process, which complements our PHEMT line. In particular for point-to-point links we are producing 2 W power amplifier at 45 GHz.

"Point-to-multipoint is not very popular yet but we have some customers who are working on this telecom niche in the millimetre-wave range with specifications requiring our most advanced processes.

He also confides, "We are about to release the second tunnel diode product. It is a matched tunnel diode, which is similar to the one already on the market, with a better low frequency noise. This is for the security market.

"GaN is 100 nm – extremely short – and will be a replacement for our GaAs processes in the long term. It is not the low frequency GaN, like TriQuint and UMS are doing but will be at very high frequencies. We are aiming for 1 W at 94 GHz. This is something we have been talking about for some time. We have not gone into production yet but we are moving in the right direction. For instance, we have completed the process of regrown

Ohmics which is key in achieving ft and fmax similar to our GaAs PHEMT processes in addition to a much higher breakdown voltage. It is continuous improvement and moving from GaAs to GaN is a natural evolution."

When asked about the ways that GaAs foundries are innovating Rocchi's reaction is: "Most of them are not because they take a short term view. I have the big advantage of having shareholders today who believe in

long term technology and long term roadmapping. This is essential. If you are a big foundry you need big volumes and big applications and they cannot afford to develop the niche technologies that we do, which is good news for OMMIC.

“However, GaAs foundries in the US are innovating. I am not sure if this is always their naturally chosen strategy or more the influence of DARPA. That is the big difference –OMMIC is an independent company and our strategy is dictated by ourselves. We are innovating because we are talking to very advanced companies.”

Moving on to RF GaN and its likely market penetration in the next five years he states, “GaN can be a replacement for GaAs. With regards to the replacement of LDMOS I have real doubts, simply for cost reasons.

“For the niche markets I believe that GaN has all the features required to replace GaAs, with the exception of some applications like HBT for VCOs and ADCs and DACs, and extremely low noise amplifiers using metamorphic, with the rest being GaN.

“When we are talking about professional applications – not the consumer PA – I think GaN can replace GaAs. For me it is natural evolution, whether it will be on Silicon or Silicon Carbide is debatable. There could be a price issue with silicon carbide, which is why we have decided to start with a Silicon substrate”

OMMIC has always had a clear roadmap focused on developing advanced technologies for clearly identified system needs. So, when asked to give Microwave Journal advanced information of where specifically that roadmap will lead in 2014 Rocchi confided, “The first thing is that we will be introducing our 40 nm metamorphic. This process is the natural evolution of the 70 nm and it is aimed at applications up to 300/350 GHz. We have just released the first wafers and we feel very good about it. This will enable us to go down to a noise figure of below 2 dB with 30 dB at the W-band – that sort of performance.

“The second thing is GaN, 100 nm on silicon. We are aiming at typically 6 W at 45 GHz and 1 W at 94 GHz. We have already released a PDK for that, so people can start designing into it. We will also release the tunnel diode with matching circuit. These diodes will have an improved low frequency noise figure. They are also temperature independent, which is essential. In microwave imaging you measure temperature differences, so the temperature stability of the front-end is essential. Finally, we will introduce our 0.5 micron emitter – 300 GHz HBT.

“This is a lot of work.”

Rocchi emphasises: “There are still people who don’t understand why we do not do everything with Silicon and I have been trying to explain why.”

He concludes: People know that OMMIC is a niche player. We are now growing the company to a sustainable size. By being a process and product leader, we will continue to attract those customers who are interested in advanced processes for advanced systems and that is the company strategy.