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Press Release

Cream of the Crop: Sandwich Chips Combining the Best of Two Technologies

Two Leibniz institutes broke new technological ground and successfully combined their – up to now separate – technology worlds. Due to their high performance the novel chips developed within the HiTeK project shall open up new applications.

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Wolfgang Heinrich and Bernd Tillack are convinced of holding the key to faster and more powerful terahertz chips. The two scientists and their teams come from the Berlin-based Ferdinand-Braun-Institut (FBH) and from the IHP–Leibniz-Institut für innovative Mikroelektronik in Frankfurt/Oder – and thus from two different technology worlds. FBH is one of the leading institutes in developing III-V semiconductors, while IHP is specialized in silicon-based systems and circuits. Both Leibniz institutes joined forces within the HiTeK project to combine the advantages of silicon-based CMOS (Complementary Metal Oxide Semiconductor) circuits from the IHP with those of indium-phosphide circuits from the FBH. The partners now accomplished an important step within the project by successfully integrating both circuits on a semiconductor wafer, with measurement results demonstrating their high performance. With the integration on one chip, new ambitious applications in the THz range are within reach such as high-resolution imaging systems for medical and security technology as well as ultra-broadband mobile communication applications.

For such applications high output powers along with faster computer processors are needed offering enhanced computer operation per second. In order to achieve this, circuits on the chips have to become smaller ¬– the key reason which boosts miniaturization in semiconductor industry. If the frequency range around 100 gigahertz and beyond is to be covered, however, the breakdown voltage in the CMOS switching circuits decreases significantly. Accordingly, the available output power of the chips declines, which implies that the capability to generate sufficiently strong signals to establish a radio link and to detect material defects becomes insufficient. To find a solution for this problem, IHP conducts research on bipolar CMOS based on silicon-germanium enhancing the breakdown voltages at high speed compared to pure CMOS. By combining a standard CMOS circuit with a second indium-phosphide circuit promises further improvement. Both circuits are realized “sandwich-like” on top of each other. Where the traditional silicon-based CMOS technology reaches its limits, this novel material combination delivers the desired properties: high output powers at high frequencies. The sandwich chips allow to keep benefiting from the high level of production routine and integration of CMOS circuits – particularly regarding the fact that 95 % of all digital and analogue-digital circuits base on this technology.

“It was particularly challenging to make both technologies compatible at the interfaces”, underlines Wolfgang Heinrich from the FBH. To achieve this, the whole development environment of both processes as, for example, the software for the circuit layout had to be merged in a first step. Subsequently, both layers had to be dimensioned so that they reach the essential good transmission properties for frequencies around 200 gigahertz. Precision work was also highly demanded to adjust the circuits precisely to each other with an accuracy of less than 10 micrometers. Heinrich is especially proud of the friction-less cooperation: “We managed to align both technology worlds so smoothly that the circuits deliver fully the specified high-frequency performance. This also demonstrates what added value can be created by bundling the competencies of two institutes like IHP and FBH”.

The next steps are now to further stabilize the process and to optimize the circuits. A follow-up project has already been granted. This way, the potential of the hybrid chips shall be exploited fully to reach the borders of what is feasible – thus setting the stage for the novel sandwich circuits to be integrated in sophisticated applications soon.

The related **press picture** and further images are provided on our website: http://www.fbh-berlin.com/press/download-center. All images are copyrighted.

For further information:

Petra Immerz, M.A.
Communication & Public Relations Manager

Ferdinand-Braun-Institut
Leibniz-Institut fuer Hoechstfrequenztechnik
Gustav-Kirchhoff-Str. 4
12489 Berlin, Germany

Phone +49.30.6392-2626
Fax +49.30.6392-2602

Email petra.immerz@fbh-berlin.de
Web www.fbh-berlin.de

Backgroundinformation – the FBH

The Ferdinand-Braun-Institut, Leibniz-Institut fuer Hoechstfrequenztechnik (FBH) researches electronic and optical components, modules and systems based on compound semiconductors. These devices are key enablers that address the needs of today's society in fields like communications, energy, health, and mobility. Specifically, FBH develops light sources from the visible to the ultra-violet spectral range: high-power diode lasers with excellent beam quality, UV light sources and hybrid laser systems. Applications range from medical technology, high-precision metrology, and sensors to optical communications in space. In the field of microwaves, FBH develops high-efficiency multi-functional power amplifiers, and millimeter wave frontends targeting energy-efficient mobile communications as well as car safety systems. In addition, compact atmospheric microwave plasma sources that operate with economic low-voltage drivers are fabricated for use in a variety of applications, such as the treatment of skin diseases.

The FBH has a strong international reputation and ensures rapid transfer of technology by working closely with partners in industry and research. The institute has a staff of 250 employees and a budget of 22 million Euros. It is part of the Forschungsverbund Berlin e.V., a member of the Leibniz Association and plays an active role in various networks.
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