

Technology preview #2

“Draft on advanced semiconductor technologies (AST)”

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In the global semiconductor production chain, the three main production steps are: **design, fabrication (front-end) and testing, assembling and packaging (back-end)**. The fabrication process of miniaturizing chips starts to reach its physical limits. As a result, technical advances on the front end of chip manufacturing are slowing, and the economically viable maximum size of a die, just like its performance, are becoming more limited. Chipmakers are being forced to identify alternative means to keep improving performance. A key technology to enhance functionality and improving chips further is **advanced packaging, e.g. processes in the back-end production that combine multiple chips to enhance performance**. It integrates multiple devices into one package as a single electronic device. By integrating or packaging multiple chips (same kind or different varieties) more closely together, **chipmakers can increase speed and efficiency while circumventing the limits of miniaturization in the fabrication process**.

Why is advanced packaging important:

These technologies have been outsourced to third countries in the past, as they were considered low complexity and not very valuable. However, as these areas are becoming increasingly complex and important steps in the semiconductor production process, it would be strategic to strive towards industrial capacity along the value chain in Europe. This requires upfront investments to foster the required European businesses.

Advanced packaging is the next step for improving and innovating the functionalities of chips in the more-than-Moore segment. Chips with specific functionalities are combined into packages of various chips creating a system with unique and optimized functionalities. **Advanced packaging provides better power efficiency, high performance (bandwidth, latency, increase I/O density), package size reduction, faster time to market, and costs reduction. Finally, the integration of chips with different functionalities is the key driver for innovation in the market segments of advanced packaging.**

Possible application areas:

- 5G/6G applications.
- high performing computing (HPC)/AI.
- consumer electronics.
- integrated photonics and in the future quantum technologies.

European Ecosystem for advanced packaging:

Due to the concentration of OSATs (Outsourced Semiconductor Assembly and Tests) in Asia, **it is difficult for European SMEs and start-ups to compete with larger chip companies**, which have easier access to these services. As chip technology is becoming increasingly complex, **there is an increasing need for the front- and back-end of chip production to be co-designed, resulting in better and more efficient products**. Due to the minor presence of OSAT services within Europe, co-designing chips in close collaboration with the packaging industry becomes much harder for European businesses, which puts them at a disadvantage. This is especially the case for start-ups and SMEs, for whom proximity and local collaborations are even more important to successfully innovate and who often do not have the resources for sustainable transcontinental collaboration.

In Europe, we have relevant knowledge and packaging competencies, for example in the Fraunhofer Institute or CITC. We also have many businesses who can make relevant contributions to advanced packaging technology. However, as the vast majority of advanced packaging facilities are located in Asia, European businesses face a high threshold in different dimensions to valorise their technological knowledge into valuable products. **Europe needs to act now in order to build up a market position in advanced packaging, or else this market will also be dominated by Asian countries, as the technology barrier for market entry and economies of scale will increase over time.**

Advanced packaging is a difficult market to enter, given the high upfront costs, the technology barrier, and the high financial risk in setting up production facilities. Given these factors, a new initiative can help kickstart the development of advanced packaging production facilities in Europe. This in turn can lead to the formation of a broader ecosystem of companies focusing on various aspects of advanced packaging.

Opportunities for European Industries:

Within Europe there is a need to package chips which make use of specific **technologies which require low-to-mid volume packaging capabilities**. The commercialization of these state-of-the-art packaging techniques is essential for these companies. Furthermore, new and novel, potentially disruptive, packaging techniques developed within the European research centres lack possibilities to commercialize their innovations in packaging facilities.

Alignment with strategic initiatives:

As advanced packaging is gaining increased attention, related activities have already been embedded in the IPCEI ME/CT. A strong alignment is needed within other strategic initiatives as well, like the European Chips Act, the current and future Framework Programme and with the results of the EU project, Pack4EU.

Summary:

The initiative aims for the R&D and FID of advanced packaging techniques developed in research centers and R&D-labs across Europe to production facilities. This covers the whole value chain including suppliers of equipment. **The aim is that these new packaging facilities meet the new demands from industry**. Packaging production needs to be accompanied by system/package design services/houses, packaging equipment and test facilities to have the best access for SMEs and start-ups to make use of the packaging production. A sustainable advanced packaging technology platform can make advanced packaging production in Europe economically feasible, including for small series production.