Companies that develop high-tech equipment for the production of systems-in-package frequently lack the requisite up-to-date, specific knowledge to develop such equipment. TNO Science and Industry’s team of specialists in many relevant disciplines, like contamination control, measuring and testing equipment, precision mechanics, data-acquisition, algorithms and printing, can help. We can find the unique solution to your problem and help you quickly get a new machine to market.
System in a Package

In the world of professional and consumer electronic, new products are getting to market faster and more cheaply. This is partly attributable to the ‘System in Package’ (SiP) that contains various components: nearly always a chip with a specific function as well as, for instance, capacitors and RF components. The whole ‘package’ can fulfil a certain function relatively autonomously. Think of an FM radio that manufacturers can simply add to a phone or MP3 player. The trend is clearly heading along the modular construction path, enabling new models to be introduced more easily and cheaply. Of course, this becomes a more attractive proposition when the series of ‘packages’ are large. Manufacturers of these products tend to be in the semiconductor industry where companies produce SiP’s in bulk for integration by others into end products, like mobile phones, MP3 players, PDA’s and more. Assembly of SiP’s requires high-tech equipment, and TNO Science and Industry can help companies develop this high-tech equipment. The knowledge and experience of TNO comes into play in the value chain right from the moment that the chips are cut from the silicon wafer till the SiP is placed on a PCB (Printed Circuit Board) and put in the end product.

SiP’s are small (around one cubic centimetre) and the components inside are very close to each other. The challenge is to place the components with great care and precision, so continuous measuring and testing is vital. If a SiP is found to be ‘imperfect’, it is discarded. Repair is not feasible, given the small scale and the on-going construction process. So the construction has to be right, from the start, or the costs will escalate.

Why TNO?

Because TNO has a range of disciplines and a team of specialists can explore several different aspects of a problem and arrive at an often unexpected solution. It is this multidisciplinary aspect that enables TNO to understand the different steps involved in the production process of SiP’s. TNO’s knowledge and experience extend far beyond the semi-conductor industry. There are few companies that have such a range of disciplines in house. In designing a completely new machine to make SiP’s, companies quite quickly come up against a deficiency of specific knowledge. Knowledge that TNO has in abundance. TNO can, for instance, take responsibility for specific problems within such a project. TNO competencies thus complement and supplement those of the company’s own competencies and help get the new machine to market faster.

Another option is for TNO to help a manufacturer at the innovation stage to enable it to strengthen its hand in a particular market. Or for TNO to independently think up a clever solution that the manufacturer can use in entering the market.

TNO specialism’s

Contamination

The chips and other components used in SiP’s are very small (millimetres) and chips are connected to each other and other components with very tiny connections, making these systems highly susceptible to short-circuits caused by roaming particles. If contamination occurs on imaging components, like a CCD chip, then the image will not be recorded and the component will not perform as it should.

The solution to this problem comes in two stages. First, the contamination must be observed through ‘contamination control’. If this is successful, the contamination can be removed by various techniques that are also employed to stick the silicon and clean mirrors. Examples are plasma and CO₂ snow cleaning. TNO Science and Industry is well experienced in both techniques.
Science and Industry has abundant knowledge and experience when it comes to reliable optical measurement set-ups. But it is not just optics but also image processing, data acquisition and the clever use of algorithms that can be used to obtain specific information from gigantic data streams.

**Electronic testing**
All components need to be electronically tested: do they indeed perform as they are required to perform? This is done for both the components and the end product: the SiP. In electronic testing the challenge lies mainly in the small dimensions and very precise positioning. For this the ‘probes’ have to be extremely small.

Although these techniques are the main ones, testing can also be done on the basis of infrared light, sound, etc. TNO Science and Industry can offer companies a suitable solution for the issue of which is the best method of measuring. The advantage of TNO in this respect is that we are not only multidisciplinary but also independent, so there will never be a question of favouring one measuring method over another.

**Precision mechanics**
The machines that produce SiP’s often require nanometre precision so the motors and other moving components must also comply with the specific demands. Bringing such a system together is extremely precise work and has to be done in line with specific regulations. TNO Science and Industry has plenty of experience in such issues, even having developed a special ‘gripper’ for gripping components. It is very light, which means that the forces are much lower upon contact. This in turn produces higher accuracy without any loss in the speed of processing.

**Data acquisition**
Huge data streams emanate from the vision systems referred to above. In order to make good use of the data, it has to be processed, within an acceptable time frame. A focal part of TNO’s work is data path architectures whereby there is a ‘real time’ requirement and TNO is able to solve such a development process through having all the requisite knowledge at its disposal (hardware, software, control and physics disciplines). And, of course, the environmental factors that influence the result also have to be taken into consideration.

**Algorithm development**
To get the information out of the data streams, mathematical algorithms are needed. TNO Science and Industry has, for instance, worked in a previous project to detect scratches on a surface containing a regular pattern, which is a tricky problem because you have to determine whether a line is an undesired scratch or part of the pattern.

**Printing**
Within TNO Science and Industry there is a department that is fully devoted to printing. Inkjet printing is the ideal flexible technology to deposit very small droplets of materials on the required spot without contact and with a high degree of precision. Now that a large number of print heads can be used, high processing speeds are achievable.

The printing of solder compounds enable the so-called ‘interconnects’ (conducting connections) between chip and components or between SiP and PCB. The trend is also towards more accurate and faster inkjet printing. More materials will also be able to be processed in this way.
High-end Equipment

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