Results of Advanced Methods and Tools for Handling & Assembly in Microtechnology
EC FP6 Marie Curie Research Training Network

ASSEMIC- Advanced Handling and Assembly in Microtechnology (**www. assemic.net**) is a Marie Curie Research Training Network which is devoted to training and research in handling and assembly in the microdimension, involving advanced methods and tools and providing a multidisciplinary, complementary approach, which joined 14 EU countries and is coordinated by Prof. Werner Brenner from ISAS-TU Vienna (**Werner.Brenner@TUWien.ac.at**).

The Network is an important opportunity for East European countries to be involved in new and innovative collaborative research in the field of micro-nanotechnologies, especially in handling and assembly of hybrid micro-systems.

ASSEMIC include also teams from Less Favoured Regions, Candidate Countries and Associate Countries. Two institutes from East countries are trained and hosted fellows: Warsaw University of Technology and IMT Bucharest. Also many appointed ESR (Early Stage Researcher) and ER (Experienced Researcher) are coming from East Europe: Bulgaria, Belarus, Hungary, Moldavia, Poland, Romania, Serbia. They are provided with intensive training on relevant topics within the project, in host institutes from West European countries, strengthing the ability to work in interdisciplinary teams.

The network offers an excellent research and training "platform" for promoting cooperation and interaction among Member States, Candidate Countries and Associated Countries, joining their experience, knowledge, enthusiasm of young fellows for getting more scientific results in the emerging field of micro-nanotechnologies, contributing to the research integration in ERA.

In 2006 the ASSEMIC Network stated his 3rd year of activity. A lot of progress in term of scientific knowledge has been done by the fellows, supervised by the scientist in charge of their host institutes. Also a special attention was focused on training and dissemination: Summer Schools, Workshop, Open Academic Seminars, Info Days with the participation of SMEs and Industry were organized.

We present some highlights, of each workpackage, of the cooperative work of the fellows (currently 18) appointed and trained in the ASSEMIC Marie Curie Training Network .

Workpackage I

Micropositioning involves high-accuracy positioning and integration of position-sensing devices for sensory feedback in microhandling applications. One of the highlights of ToK in this WP was the large effort of UNINOVA's ESR to integrate and demonstrate the polysilicon optical array sensor – a low-cost device in comparison to normal silicon photosensors). IMT also performed very relevant work on design and simulation of micropositioning proximity sensors based on photodiodes and optical waveguides using interference phenomena.

Furthermore, Seibersdorf began cooperation with RAL for investigating the use of SU8 microcantilever arrays in autonomous mobile platforms for microrobots. Seibersdorf has designed and developed special non-silicon substrates with vertical interconnects for the production of the cantilever arrays studied at RAL, which are based on the bimorph thermal actuation principle. This innovative approach paves the way for highly efficient mechanical and electrical integration of cheap polymer actuator devices. Further contributions comprise the work of IMT and Uni-Oldengurg on microrobotics modelling and enhancement of mobile robots for manipulation in an SEM chamber.

Workpackage II

Microhandling involves techniques and tools for microhandling and micro-manipulation operations, such as pick-and-place, alignement, etc. The work on gripper systems has led to a considerable number of novel microgripping prototypes and designs. ISAS's magnetic microgripper has been integrated into Robotiker's microrobot. Nascatec's grippers have been made available to all ASSEMIC partners, which has led to an important number of cooperation projects. For example, integration of Nascatec's gripper with Robotiker's microrobot and position feedback with UNINOVA's.

Experiments for the purpose of coating Nascatec's grippers with special selected materials investigated and chosen by WUT and FORTH are being carried out and could represent a great innovation in micro-handling technology by enabling enhanced conditions for coping with the so-called sticking effect. Other methods implemented and/or tested by another group of partners for enabling sensory feed-back from end effectors were: a three-axis force sensor, a realtime reflection and triangulation 3D position sensor, ink marking and FIB modified grippers for visual recognition of the tips (Uni-Ol, UNINOVA, SSSA).

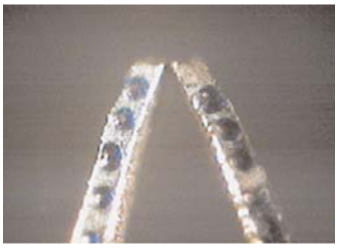

Fig. 1 SSSA polymer ink marking on stainless steel griper tips

Moreover, a number of results have been reported concerning automated and/or teleoperated assembly stations (involved partners: Robotiker, Uni-Ol, ISAS, SSSA and Seibersdorf Research). Even though automated assembly stations do exist and a number of systems are commercially available, there is still room for innovation. Specifical-ly, Uni-Ol is also working on a solution for satisfying the need for an easy way to couple and decouple different haptic devices to and from the currently existing control loop by integrating an available haptic device (SensAble PHATOM) and integration of a 1-DOF end effector for force-feedback-enabled gripper control into its stylus. This would represent a novel device currently not available for suitable operation of micro-robots with haptic devices specific to large-scale industry. Significant progress has also been reported for the task devoted to biological and medical applications. One important result is the joint effort by several partners to use technology being researched in Progenika for functionalizing arrays of cantilevers supplied by Nascatec, RAL and IMT (Fig. 2).

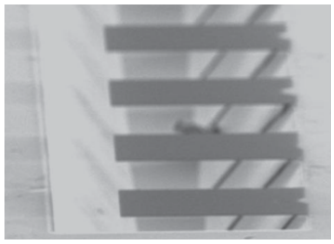

Fig. 2 Microcantilevers (IMT)

Workpackage III

Microassembley is devoted to advanced tools and systems for microassembly applications, and also involves joining and bonding issues. A particular highlight is the implementation of a new concept for bonding parts from 50 to 300 µm by softening glue applied in a solid state with a focused and concentrated hot gas stream as a result of external cooperation with a German university. Experimental results were in agreement with ANSYS's finite element analysis simulation. Further work has also been performed by FhG/ILT on pick & join tools, which will be the basis for planned cooperation with other ASSEMIC partners. ILT, SSSA, ISAS and FSRM are not only performing theoretical investigation of microassembly systems, such systems are also being tested for the assembly of hybrid microsystems, such as sealing polymeric microfluidic devices, micro-solderer resistors (150x300 µm in size), optical fibers in grooves and 8x8 cross connection switches.

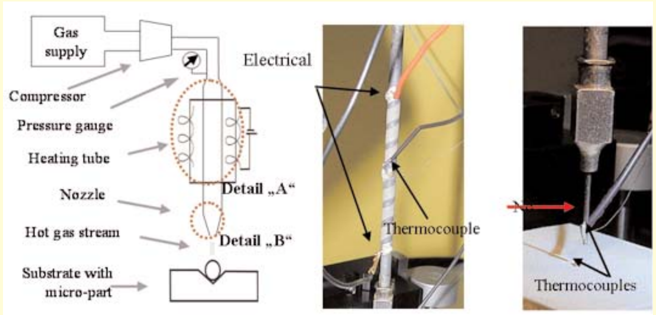

Fig 3. a) Schema of experimental set-up for micro-joining by hot gas stream. b) Photograph of the heating element realized on a metal tube in thick film technology equipped with a thermocouple and electrical connections. c) Photograph of the nozzle and substrate carrying thermocouples (TU Vienna)

Workpackage IV

Automation of industrial microassembly, started in 2005, focuses on two different aspects. Firstly, automated handling and assembley with intelligent control techniques is being explored. An initial study of feasibility, with contributions by Robotiker, Seibersdorf, Uni-Ol and WUT, has already been reported in the relevant Deliverable. Secondly, a special effort has been made relating to the issue of testing and characterization of assembled microsystems, which is also very important. One of the more outstanding results is cooperation in developing a method of automated characterization of Nascatec's integrated microcantilever devices by machine vision (Robotiker) and/or optical array sensor (UNINOVA). Characterization of micro-cantilevers is currently done in a manual process. Automation of the calibration process of single cantilevers, and especially of cantilever arrays, leads to an important increase in reliability and speed during device characterization. Other highlights of this Workpackage are WUT's rig prototype for testing adhesive, tribological, dynamic and mechanical properties of MEMS structures; SSSA's characterization of SMA and piezoelectric actuators (cooperation with Seibersdorf Research); and testing of IPMC. FORTH has presented results on hardness tests of thin metal oxide films candidates for the elimination of parasitic effects. Finally, the microdevice torque measurement system developed at the ISAS also deserves special mention. Based on the cable-brake method, it was designed as a test device for mini- and micromotors.

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