# Programmable Self-assembly Method for Nanocomponents and Microcomponents

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# NanoComponent and MicroComponent Directed, Programmable Self-Assembly

Programmable self-assembly is a breakthrough directed self-assembly method that enables low-cost, highly consistent and high volume manufacturing of complex meso systems and devices (optical and fluidic, integrated circuits, sensors, actuators). Programmable self-assembly enables batch integration both in two and three dimensions, is highly parallel and works up to 1000 times faster than robotic manufacturing.

Programmable self-assembly is scalable and forms electrical interconnects between micrometer and potentially nanometer sized components which allows the resulting nanocomponents to be 10-100x smaller.

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# **Liquid Solder Receptors**

The self-assembly-by-design concept uses patterned surface areas (receptors) to attract and electrically connect device components to form a functional device. The interaction driving the self-assembly is based on capillary forces between liquid solder drops and correspondingly shaped metallic binding sites on the components. Geometrical shape recognition is used to identify non-identical components which allow rapid reconfigurations by merely redesigning receptors that direct the assembly process (rather than reprogramming robots). Metal contacts on the semiconductor devices bind to the liquid solder-based receptors on a substrate surface during fluidic self-assembly. Different from existing concepts, the proposed self-assembly-by-design tool will be programmable, which means that selected receptors can be activated using an external voltage and assembled using the current CMOS manufacturing infrastructure.

# **Microelectronic and Optoelectronic Applications**

This technology platform has applications in the production of current electronic devices such as integrated circuits, radio frequency identification (RFID) tags, optical and photonic devices,

# **Technology ID**

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# Category

Engineering & Physical Sciences/Nanotechnology Engineering & Physical Sciences/Semiconductor

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sensors, actuators, displays, and fluidic devices.

## FEATURES AND BENEFITS OF PROGRAMMABLE, RECONFIGURABLE SELF-ASSEMBLY:

- Works in two and three dimensions, is highly parallel, and much faster than robotic manufacturing.
- Programmable and enables batch integration of different devices (i.e. different sources out of varying materials).
- Allows rapid reconfigurations by reprogramming receptors that direct the assembly process and makes use of the current CMOS manufacturing infrastructure.

**Phase of Development** Proof of concept complete. Six hundred AlGaInP/GaAs light-emitting diode (LEDs) segments self-assembled onto device carriers in 2 minutes without defects. Encapsulation units self-assembled onto the LED-carrier assemblies to form a three-dimensional circuit path to operate the final device.