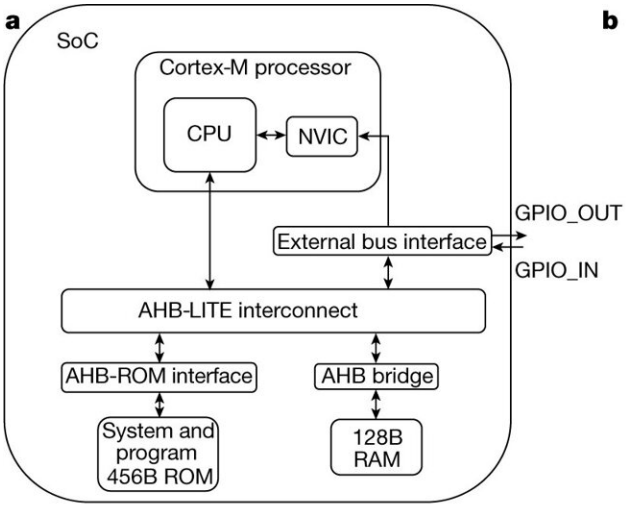
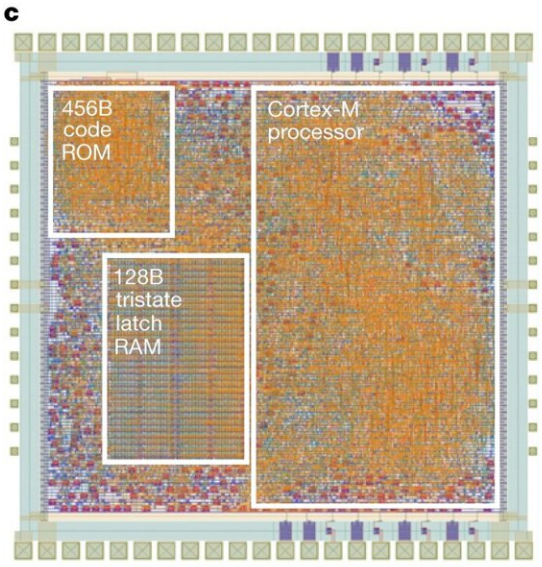
Flexible 32-bit microprocessor could pave the way to fully flexible smart integrated systems

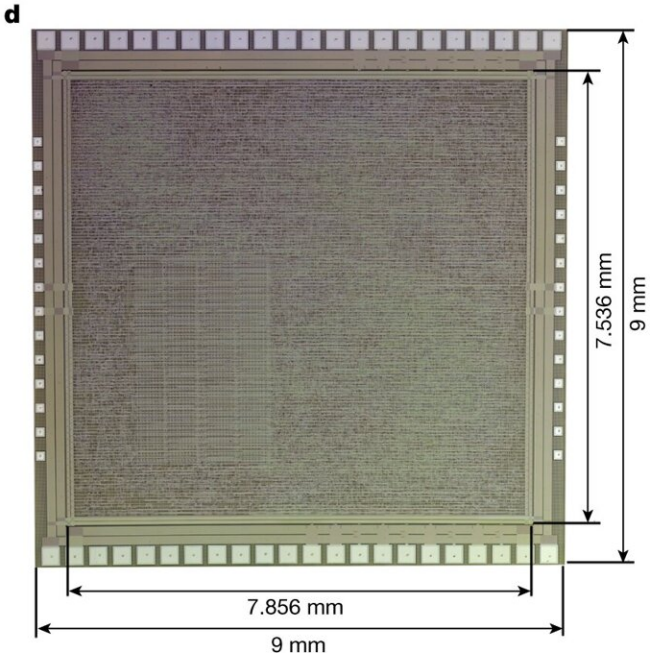
July 26 2021, by Bob Yirka



b

Features	Cortex-M0+ CPU	Cortex-M CPU in PlasticARM
Processor architecture	ARMv6-M	ARMv6-M
Instruction set architecture	16-bit Thumb and a subset of 32-bit Thumb	16-bit Thumb and a subset of 32-bit Thumb
Data and address width	32	32
Number of instructions	86	86
Pipeline	2-stage	2-stage
Architectural register file	Inside the CPU	Mapped to RAM external to the CPU
Binary compatibility	Can run code from other Cortex-M CPUs	Can run code from other Cortex-M CPUs including Cortex-M0+





PlasticARM architecture and features. a, The SoC architecture, showing the

internal structure, the processor and system peripherals. The processor contains a 32-bit Arm Cortex-M CPU and a Nested Vector Interrupt Controller (NVIC), and is connected to its memory through the interconnect fabric (AHB-LITE). Finally, the external bus interface provides a General-Purpose Input-Output (GPIO) interface to communicate off-chip with the test framework. b, Features of the CPU used in PlasticARM compared to those of the Arm Cortex-M0+ CPU. Both CPUs fully support Armv6-M architecture with 32-bit address and data capabilities and a total of 86 instructions from the entire 16-bit Thumb and a subset of 32-bit Thumb instruction set architecture. The CPU microarchitecture has a two-stage pipeline. The registers are in the CPU of the Cortex-M0+, but in the PlasticARM the registers are moved to the latch-based RAM in the SoC to save the CPU area of the Cortex-M. Finally, both CPUs are binary compatible with each other and to other CPUs in the same architecture family. c, The die layout of PlasticARM, denoting the key blocks in white boxes such as the Cortex-M processor, ROM and RAM. d, The die micrograph of PlasticARM, showing the dimensions of the die and core areas. Credit: *Nature* (2021). DOI: 10.1038/s41586-021-03625-w

A team of researchers at ARM Inc., has developed a 32-bit microprocessor on a flexible base which the company claims could pave the way to fully flexible smart integrated systems. In their paper published in the journal *Nature*, the group describes how they used metal–oxide thin-film transistors along with a type of plastic to create their chip and outline ways they believe it could be used.

Microprocessors power a wide range of products, but what they all have in common is their stiffness. Almost all of them are made using silicon wafers, which means that they have to be hard and flat. This inability to bend, the researchers with this new effort contend, is what is preventing the development of products such as smart clothes, smart labels on foods, packaging and even paper products. To meet that need, the team has created what they describe as the PlasticARM—a RISC-based 32-bit microprocessor set on a flexible base. In addition to its flexibility, the

new technique allows for printing a microprocessor onto many types of materials, all at low cost.

To create their bendy microprocessor, the researchers teamed with a group at PragmatIC Semiconductor to create a bendable version of the Cortex M0+ microprocessor, which was chosen for its simplicity and small size. To make their chip, (which includes ROM, RAM and interconnections) the team used amorphous silicon fabricated (in the form of metal-oxide thin-film transistors) onto flexible polymers.

In the first iteration of their PlasticARM, the researchers put the registers used by the CPU in a reserved part of RAM, and only 128 bytes of RAM were used. The resulting microprocessor was bendable, but it was neither efficient nor fast. Also, it did not have any programable memory. But the researchers note that they are just beginning. They suggest their work thus far has shown that it is possible to make viable flexible microprocessors, which means that eventually, it could be possible to print them onto clothes and other wearable devices at very low cost. They estimate that trillions of objects in the coming decades will be outfitted with processing power, including chips that can tell you if the milk is sour, shirts that can measure body fluids to be processed by your smartphone, and labels you can paste onto to your skin to warn others of your mood. The possibilities will be constrained only by the imagination.

More information: John Biggs et al, A natively flexible 32-bit Arm microprocessor, *Nature* (2021). DOI: 10.1038/s41586-021-03625-w

https://techxplore.com/news/2021-07-flexible-bit-microprocessor-pave-fully.html