Project funded by the Horizon 2020

Grant Agreement no. 829010

PRIME

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DELIVERABLE 2.7:
Printed actuating functions (public version)

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Actual Submission Date:	**29/07/2022**
Responsible partner:	CSIC
Report Author(s):	Zehra Kahveci, Carlos Sánchez-Somolinos
Type1[1]:	R
Dissemination Level[2]:	PU

[1] **Type**: Use one of the following codes (in consistence with the Description of the Action):
R: Document, report (excluding the periodic and final reports)
DEM: Demonstrator, pilot, prototype, plan designs
DEC: Websites, patents filing, press & media actions, videos, etc.
OTHER: Software, technical diagram, etc.

[2] **Dissemination level**: Use one of the following codes (in consistence with the Description of the Action)
PU: Public, fully open, e.g. web
CO: Confidential, restricted under conditions set out in the Model Grant Agreement
CI: Classified, information as referred to in Commission Decision 2001/844/EC

DELIVERABLE D2.7: *First printed actuating functions*

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1. Document History

Version	Date	Authors/ who took action	Comment	Modifications made by
0.1	27/07/2022	ZK and CSS	First draft sent to PIs	
1.0	29/07/2022	CSS	Submitted to Commission	

Initials used:

CSS Carlos Sánchez-Somolinos (CSIC)

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2. Results and Outlook

Microfluidic devices can manipulate small amounts of liquid allowing cost-effective, accurate, fast and high throughput analytical assays. Microfluidics is an expanding area however existing technologies suffer several numbers of limitations that heavily limit the global microfluidics market. These limitations include complexity of the equipment that limiting their application to highly specialized laboratories and high prices of the large-scale off-chip equipment. PRIME aims to go beyond the state-of-the-art generating a robust platform to create a new generation of active, tubeless and contactless microfluidic chips effectively changing the currently established paradigm. PRIME is developing a radically new platform that: i) integrates all the required responsive materials and elements in the chip, effectively providing it with all the fluidic and sensing functions, ii) uses compatible materials and manufacturing technologies making future industrial production viable and cost-effective, iii) allows the implementation of a plethora of new smart-integrated and easy-to-operate microfluidic chips with extensive design freedom. PRIME is implementing and integrating through additive manufacturing technologies smart valves and pumps in a microfluidic chip. PRIME aims to set the basis of a new technology that could not only make industrialization possible, but also bring smart material properties to the scenario, enabling the monolithic integration of new functional capabilities (Figure 1). The final device will be remotely addressed and read using simple photonic elements that can be integrated in compact, portable and cheap operation & read devices.

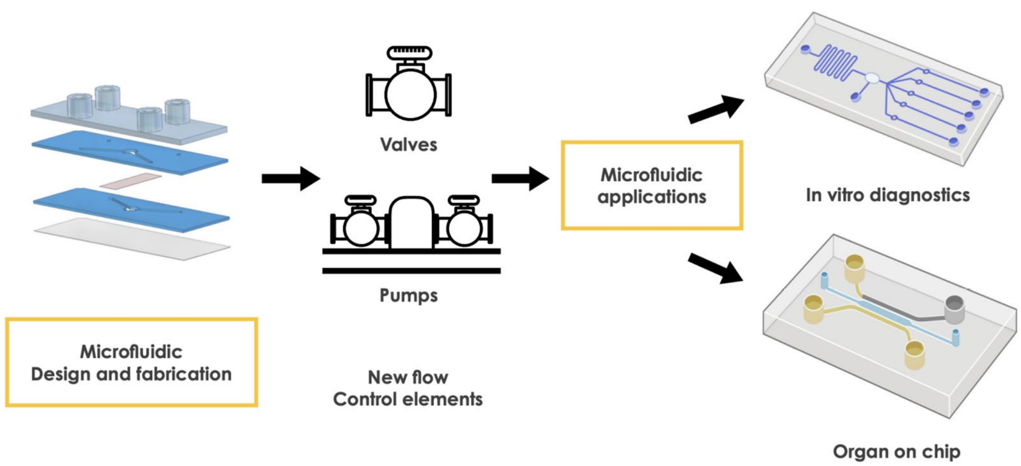

Figure 1: PRIME is implementing integrated valves and pumps with active fluidic elements that will allow an accurate flow control for microfluidic applications.

A fundamental pillar of PRIME is 4D printing of responsive materials. While 3D printing of conventional materials typically leads to inanimate objects, 4D printing of responsive materials adds the time as a fourth dimension, creating objects that can change their shape over time in response to an appropriate stimulus (Figure 2). For integrated active chip elements, it is important to achieve a large and fast shape morphing. To achieve this, PRIME is developing robust and reproducible synthetic procedures to yield high quality inks and printed actuators with enhanced response. Advances in the materials are being connected with the modelling approaches. The support from the modelling and simulation is used to predict how the components of the device

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will behave under different conditions. This will close the gap between the developed materials and chip active elements that are being developed under this task, progressing towards the milestones and the objectives of PRIME.

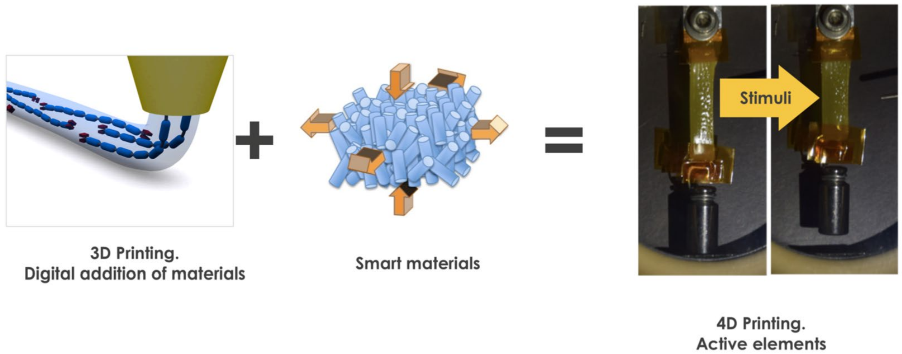

Figure 2: 4D printing of smart materials.

In this task, we have developed different strategies for implementing actuating functions. Different geometries and integration strategies have been investigated leading to microfluidic devices incorporating the concept of the PRIME valve based on smart materials. Devices integrating the active element have been connected to a flow, that has been monitored under external stimuli excitation to optimize the valve function to demonstrate the concept of the basic fluidic functions pursued in the project (Figure 3).

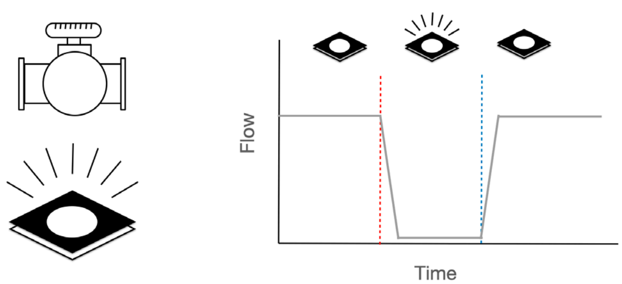

Figure 3. Concept of photoactuated PRIME valve.

We have demonstrated at this stage the valve concept able to stop a flow at a constant pressure configuration. The functional prototype of the PRIME valve at this stage is working at pressures of 10 to 50mbar and at flow rates in range of 5 to 120 µL/min with response times in range of 20 seconds (complete valve closure). Improvements of these figures are in progress within the framework of the project.

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