Horizon Europe project CORENET concludes with Scientific Breakthroughs in Complex Reaction Networks and Chemical Computing

After four years of interdisciplinary research and collaboration, the CORENET project (Complex Chemical Reaction Networks for Breakthrough Scalable Reservoir Computing) has reached its official conclusion. Supported by the European Union's Horizon Europe programme and the Swiss State Secretariat for Education, Research and Innovation (SERI), the project has delivered a portfolio of scientific advances that push the frontiers of molecular computing.

CORENET set out to explore a radical paradigm shift in computing by harnessing **complex chemical reaction networks (CRNs)** as information processing systems. Drawing inspiration from the human brain — itself a chemical processor — the project demonstrated that dynamic reaction networks contained within microfluidic environments can perform high-level computational tasks. These systems were integrated with cutting-edge machine learning techniques to extract meaningful information from the reaction outputs.

A central outcome was the successful **development and automation of chemical reservoir computing workflows**, where chemical inputs flowing through microfluidic reactors produced non-linear outputs that were analysed and interpreted to solve classification and prediction tasks. Protocols for controlling, monitoring and steering these reaction networks were established, marking a significant step toward scalable, molecule-based computing.

Scientific Recognition and Publications

Throughout the project's lifetime, CORENET partners disseminated their findings widely across the scientific community:

- Eleven peer-reviewed scientific publications by CORENET researchers appeared in respected journals, advancing both the theoretical foundations and experimental realisations of chemical computing.
- A landmark article published in *Nature*, titled *"Chemical reservoir computation in a self-organizing reaction network"*, highlighted how formose and related systems can act as molecular computing substrates. A follow-up work is being finalised in which the generalization of this concept is demonstrated by performing reservoir computer with a novel CRN developed *de novo*.
- Additional contributions included articles in *Organic Chemistry Frontiers*, *Nature Chemistry*, *Nature Communications* and the *Journal of Chemical Information and Modelling*, which explored reaction pathways, analytical strategies and cheminformatics tools relevant to CRNs.

Partners also presented at major international workshops and conferences, sharing experimental results and algorithmic innovations that underpin the project's scientific impact.

> *Understanding complex chemical systems is a major goal of current science, which will bring technological advances in chemistry and materials science. CORENET faced this grand challenge with an extraordinary group of academic and industry scientists working on systems chemistry, microfluidics, metabolomics and AI.*
> Andres de la Escosura, CORENET Coordinator

Impact and Future Outlook

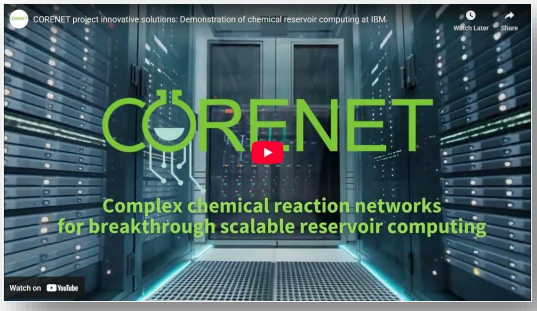
CORENET's research has advanced the concept of **reservoir computing with chemistry** from a theoretical possibility to tangible experimental systems. By combining microfluidics, analytical methods, computational modelling, and AI, the project has demonstrated core principles of chemical computing and outlined paths for future research.
Potential applications of these findings range from sustainable computing architectures tailored for complex dynamic tasks to interfaces between chemical systems and living environments. While further work is needed to scale these concepts toward practical devices, CORENET lays a solid scientific and technical foundation for the next generation of energy-efficient, molecule-based information technologies.

Interdisciplinary Collaboration at Scale

CORENET brought together four leading academic research groups with complementary expertise and a global industrial partner in AI and computing:

- **Universidad Autónoma de Madrid (UAM)** coordinated the project with leadership in systems chemistry.
- **Radboud Universiteit** developed the microfluidic reactor systems for controlled reaction networks.
- **Consejo Superior de Investigaciones Científicas (CSIC)** provided comprehensive analytical chemistry and data processing capabilities.
- **Universität Bielefeld** contributed advanced cheminformatics tools for modelling and network inference.
- **IBM Research Europe – Zurich** supplied world-class expertise in AI and machine learning integration and reactor hardware.
- **accelopment Schweiz AG** coordinated the innovation management and led the communication and dissemination of the project

This integrated effort enabled multidisciplinary progress that would not have been possible within a single field. The CORENET consortium thanks the European Commission, participating institutions, research teams, and the broader scientific community for their support and engagement throughout the project. All project outcomes including publications, presentations and deliverables remain accessible through the official CORENET website. For more details on CORENET's results and publications, visit corenet-horizon.eu.



Watch CORENET latest videos available at YouTube.