PRESS RELEASE

NOVEL NONLINEAR MATERIALS PAVE THE WAY FOR ADVANCED 3D PHOTONICS

The Project 3DnanoGiant Aims to Unlock the Power of Light by New Nonlinear Materials for All-Optical Processing

15 January 2025

Photonics, with its high bandwidth, speed, and low power consumption, has the **potential to revolutionize industries**, particularly telecommunications and computing. Building on early developments in fiber optics and lasers, photonics has already enabled high-speed data transmission, but further advancements in materials science and engineering are crucial for its continued evolution.

The groundbreaking 3DnanoGiant research project aims to advance photonics by developing new materials for all-optical signal processing with low power consumption. Funded by a European Research Council (**ERC**) Starting Grant awarded to Dr. **Sara Nocentini**, the project addresses a key challenge: the lack of integrated materials suitable for efficient nonlinear optical functions on chip.

While photonics offers significant advantages over traditional electronics by using light for information processing, realizing its full potential requires efficient light manipulation through third order nonlinear optical effects, where light interacts with itself. Current nonlinear materials often require high-power activation using high-energy pulsed lasers, limiting their large-scale application in areas like all-optical signal processing.

3DnanoGiant tackles this limitation by **combining the exceptional giant optical nonlinearity of liquid crystals** — ten orders of magnitude greater than silicon — **with a nano-porous, 3D-printable polymer network**. The nano-porous polymer network provides a 3D printable scaffold hosting a highly nonlinear material for nonlinear photonic devices working at low power.

Funded by the European Commission

"*This project offers a unique opportunity to push the boundaries of photonics,*" says Dr. **Sara Nocentini**. "*By combining my expertise in liquid crystals and advanced 3D printing techniques, we aim to create efficient nonlinear devices in hybrid polymer-silicon platforms with unprecedented performance*."

Using nanoscale 3D printing, the **project will fabricate innovative nano-micro photonic nonlinear structures in 2D and 3D designs**, including dynamic 3D+1 waveguide networks. Specifically, the project **will focus on realizing all-optical 2D logic gates**, ultrafast nonlinear activation functions, and self-oscillating 3D photonic crystals. Concurrently, research on soliton propagation, interaction, and polymerization in a 3D+1 space will lay the foundation for a new unsupervised, bottom-up 3D printing technology. These structures will exhibit high nonlinearity, high response speed, and easy integration into existing photonic platforms.

The 3DnanoGiant project aims to redefine the state-of-the-art in integrated nonlinear photonics, delivering practical and versatile heterogeneous chips for fast and energy-efficient optical processing, and contributing to the goal of "*Accelerating digital transformation and supporting industrial transition*."

THE PROJECT

Full name	3D integrated photonic nanostructures with Giant optical nonlinearity
Start date	1st January 2025
Duration	5 years
Budget	1,5 M €
Project number	101163799
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