

## **i-NanoOcuCare: A Nanostructure- and AI-Enabled Platform for Continuous In-Eye Sensing, Diagnostics, and Closed-Loop Drug Delivery**

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i-NanoOcuCare is a new nanostructure and AI-enabled platform for continuous in-eye biomarker sensing, diagnostics, and drug delivery, forming a closed-loop ocular therapeutic system [1]. The core hardware is the i-NanoOcuPlug — a plug approximately 1 mm in diameter and 3–4 mm in length, configured to fit within the lacrimal punctum (tear duct opening) of the eye. The i-NanoOcuPlug performs four functions: (i) continuously monitoring key ocular biomarkers from tear fluid flowing through the device; (ii) delivering drugs into the tear film as instructed and needed; (iii) wirelessly transmitting monitoring data to a nearby portable unit, the i-NanoOcuStation (e.g., a smartphone); and (iv) wirelessly receiving drug delivery instructions from the Station.

The i-NanoOcuStation communicates with the i-NanoOcuPlug, supplies it with wireless power, and performs diagnostics and therapeutic drug delivery determinations using monitoring data from the plug together with other relevant inputs — processed by the station itself, via cloud, or in combination. Diagnostics and therapeutic determinations are AI-driven to improve accuracy. Relevant inputs include data from a smartwatch and medical records stored in the cloud.

The sensing functions of i-NanoOcuCare employ nano-electrochemical sensors embedded in nanofluidic channels with nanopumps and nanovalves. Additional nanostructures assist the AI algorithms to further enhance measurement accuracy. The i-NanoOcuCare platform was inspired by an ARPA-H call for proposals.

[1] S. Y. Chou, U.S. Provisional Patent Application No. 63/785,951, filed April 9, 2025, entitled "Punctum-Embedded Device and Its System for Ocular Biomarker Sensing, Diagnostic, Drug-Delivery, and Therapeutics."