

Tiny Gold Particles can help early detection of Parkinson's Disease

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The yellow metal, rather tiny particles of it, can hold the key to a nanotechnology-based tool for early detection of Parkinson's Disease (PD).

Parkinson's disease is one of the fastest-growing neurological disorder globally. With an aging population and rising life expectancy, the number affected by the disease in India is projected to increase substantially, placing immense pressure on healthcare systems. Yet, most diagnoses occur only after significant neurodegeneration has already taken place.

Hence researchers are on the lookout for ways in which the disease can be detected at an early stage so that adequate measures can be taken to manage it appropriately.

A group discussion among scientists at Institute of Nano Science and Technology (INST), Mohali an autonomous institute of the Department of Science and Technology (DST) exploring how proteins behave differently in the brain during disease, sparked a big idea. They started exploring whether they could detect how dangerous a protein is just by sensing its surface charge.

They focused their attention on a protein called α -synuclein linked to PD. This protein changes shape, starting out harmless, and eventually clumping into toxic forms that damage brain cells. The team started working towards a sensor to tell these protein forms apart, just by how they're charged.

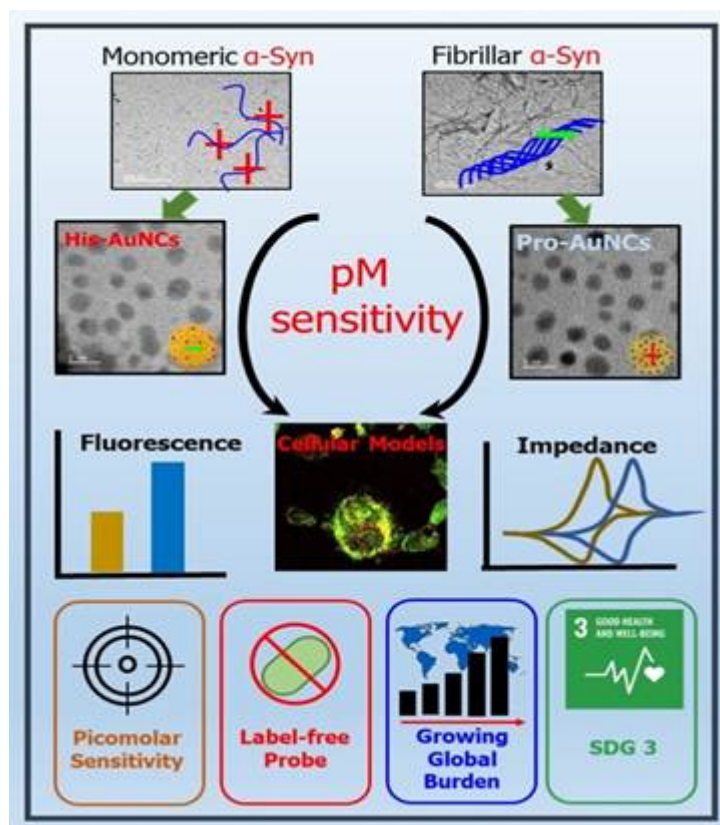


Fig: Gold nanocluster-based biosensor distinguishes between physiological and pathological α -synuclein conformers, enabling early-stage detection of Parkinson's disease.

Their solution came in the form of gold nanoclusters (AuNCs), ultrasmall, glowing particles just a few nanometers wide. By coating these nanoclusters with naturally occurring amino acids, the researchers gave them selective “stickiness.” Proline-coated clusters were drawn to the normal version of the protein, while histidine-coated ones latched onto the toxic aggregates. This helped distinguish between the harmless monomeric form and the toxic aggregated (amyloid) form.

The journey from concept to proof-of-principle involved a broad spectrum of experiments. The team began by engineering and purifying two forms of the α -synuclein protein (normal and mutant). They then synthesized the amino acid-capped gold nanoclusters and meticulously characterized them using high-end techniques such as UV-Vis spectroscopy, fluorescence imaging, electron microscopy (TEM), and X-ray photoelectron spectroscopy (XPS) to understand their optical and structural properties. The interactions between nanoclusters and proteins were studied through gel electrophoresis, fluorescence quenching, and electrochemical methods like cyclic voltammetry and impedance spectroscopy, which allowed the team to measure how sensitively the nanoclusters could detect different forms of the protein. Finally, the system was tested in human-derived SH-SY5Y neuroblastoma cells to ensure it worked safely and effectively in biological conditions.

The project was led by Dr. Sharmistha Sinha, Senior Scientist at INST, and was supported by her PhD students Ms. Harpreet Kaur and Ms. Ishani Sharma. They also collaborated with Dr. Deepak Sharma and Arpit Tyagi at CSIR-Institute of Microbial Technology (IMTECH), Chandigarh, who contributed their expertise in protein biochemistry and cell-based assays. This collaboration between young researchers and experienced scientists helped turn a simple lab discussion into a validated biosensing platform.

A tool that can detect the disease before symptoms appear could mean earlier treatment, improved quality of life, and lower long-term healthcare costs.

The research also opens the door to detecting other diseases linked to misfolded proteins, like Alzheimer’s, using similar nanotechnology. By making the system label-free, low-cost, and clinically adaptable, the team hopes it can someday be used in point-of-care testing—bringing powerful diagnostics closer to people who need them most. It could contribute to the global effort to prevent and manage non-communicable neurological diseases.

The study has just been accepted at the journal *Nanoscale* (Royal Society of Chemistry).

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