Super-Absorbent Polymer (SAP) Beads for Collection of Biofluid Samples

Fast and simple method to prolong specimen shelf life at room temperature and lower costs of remote collection for characterization and diagnostics

Inventors at Georgia Tech have developed an improved method of collecting liquid and semi-liquid biological samples (e.g., blood, urine, saliva) for subsequent characterization and diagnostics. Potentially useful for COVID-19 and other disease testing, this technology eliminates the need for refrigeration and has the potential to cut transportation weight in half, significantly lowering cost and complexity. It is poised to help address the urgent need for new advances to provide rapid, effective, and simple remote collection of biological specimens for testing and diagnosis.

The method uses super-absorbent polymer beads to absorb biofluids at the point of collection. Long used in personal hygiene products and in agriculture, pharmaceutical, and biomedical applications, SAP beads can absorb and retain large amounts of liquid—up to 1,000 times their own weight. The beads can be used to capture specific fluidic components needed for medical analysis (such as enzymes, DNA, RNA, or virus), while the unneeded components (such as blood cells and bacteria) remain unabsorbed and can be discarded. This enables stabilization of the analytical targets for longer shelf life even without cold storage, and it eliminates the need to transport the unneeded components of the sample.

Summary Bullets

- **Fast**: Accommodates preloading of specimen collection tubes and completes absorption of analytical targets within a few minutes of fluid collection
- **Low cost**: Employs economical materials and eliminates the need for refrigeration of samples while also lowering the weight of samples for transport
- **Easy to use**: Avoids the need for filtration, centrifugation, or pipetting and the associated equipment for such tasks

Solution Advantages

- **Fast**: Accommodates preloading of specimen collection tubes and completes absorption of analytical targets within a few minutes of fluid collection
- **Low cost**: Employs economical materials and eliminates the need for refrigeration of samples while also lowering the weight of samples for transport

- **Easy to use**: Avoids the need for filtration, centrifugation, or pipetting and the associated equipment for such tasks
- **Customizable**: Accommodates additional preservatives for preloading in SAP beads during synthesis to achieve enhanced protection
- **Practical**: Effectively extends the shelf life of biofluid samples, making it easier to transport them from rural and medically underserved areas for wider disease testing coverage
- **Convenient**: Opens the door to possibilities for patient-administered, home-based medical sample collection

Potential Commercial Applications

The method can be used for collection and stabilization of liquid samples (e.g., water, urine, blood, food, etc.) for:

- Clinical analysis and characterization
- Medical diagnoses

Background and More Information

Remote collection of biofluid specimens is a significant challenge due to the requirement for continuous cold storage. Without proper temperature regulation, rapid degradation of biomarkers in the specimens may compromise the accuracy and reliability of testing results. This challenge becomes even more pronounced when addressing disease diagnosis in rural areas, developing countries, and other medically underserved communities. In such areas, at-home sample collection would help ensure larger coverage of disease testing when needed, but such collection kits require constant refrigeration of samples in order to maintain sample quality. The problem grows with the high cost of cold storage and its intensive energy requirements and specialized equipment.

Alternative approaches have been promising, but none completely eliminates the need for low-temperature storage of biofluids. Dried blood spot (DBS) sampling, for instance, offers low-cost capture of blood components and can enhance long-term sample stability, but the method is hindered by extensive treatment time (more than 3 hours) and inadequate protection against high temperatures and humidity. Georgia Tech’s process provides a simple way to capture analytical targets in a biological sample and stabilize them at room temperature, significantly extending the shelf life for transport. Careful design ensures that bacteria are excluded from absorption by the SAP beads in order to avoid microbial spoilage (which is also aided by removal of blood cells and other unneeded components of the sample). Finally, the SAP beads can be preloaded with preservatives to provide additional protection.

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IP Status

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Publications

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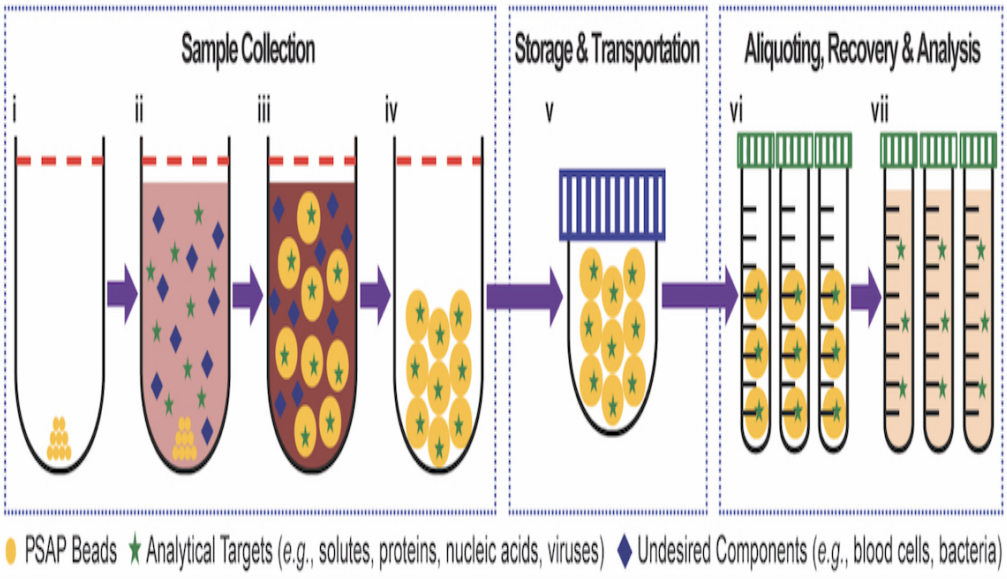
Images



A typical collection process starts with SAP beads preloaded into a sample tube with a sieve. A liquid sample is then collected and infused into the tube. The SAP beads expand to about 1-2 mm over 1-2 minutes, during which the analytical targets (e.g., enzyme, DNA, RNA, or virus) are absorbed along with water by the beads. Undesired components (e.g., blood cells and bacteria) are excluded from absorption due to their larger size. (Plasma, which may contain analysis targets, is automatically absorbed by the beads.) The leftover liquid can then be poured out, retaining only the SAP beads with analytical targets in the tube. The sieve is removed, and a lid is adhered for storage and transportation.

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