MATERIALS DEVELOPMENT FOR SWAB APPLICATORS WITH IMPROVED COLLECTION AND RELEASE EFFICIENCIES FOR DNA STR TYPING

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Traditional cotton swabs are well established in the collection of biological evidence. However, release of samples from cotton swabs, and others on the market, for subsequent DNA extraction is typically variable and inconsistent for the upstream DNA amplification and STR typing. The overall efficiency of the swab is defined as a ratio of the fraction of sample collected on the swab and the fraction of the collected sample released for the downstream analysis. Increasing the efficiency of the swab includes, not only increasing the fraction collected, but ultimately the fraction actually processed and then transferred to the analysis device. Following an extraction process to obtain the DNA from the cells, there is a loss of up to 70-85 % of the DNA. Therefore, the collection, storage and thus release of the DNA and biological matter needed for identification are inherently dependent on the swab materials and configuration. Although improvements in new packaging of swabs have been reported to avoid contamination and mishandling, none of these designs have addressed the performance in specimen release efficiency.

Currently, release efficiencies are typically low due to the incapability to transfer the cells and DNA trapped in the recesses of the swab, due to both the chemical and physical nature of the swab materials (weak bonding and physically trapping within fibers or pores). This scenario is even more deleterious with associated rape cases, wherein the quantity of male spermatozoa amount is significantly lower- leaving decreased chances in isolating the Y-STR (Y-chromosome STR).

To alleviate the constraints from trapped biological matter, our team has been designing several functional collection devices. Our current design approaches comprise of biopolymer-based materials and hybrid organic-inorganic nanomaterials tailored with specific release mechanisms such as dissolution, swelling or controlled release. These swabs can be designed for collecting buccal, blood or other biological specimen, wherein performances are improved in the area of sample preservation, sample integrity, efficiency and consistency in release of the collected forensic samples. Validation evaluates performance over a range of biospecimens, ranging from cultured cells to blood stains, to identify optimized release kinetics, as well as quantify and quality of the biospecimen for STR typing. These selected materials are designed and fabricated as a user-friendly, highly efficient prototype that can improve DNA yield by at least 50%, for trace cases, increasing concentrations from picograms to nanograms. Additionally, we are also investigating to interface these swabs with lab-automated systems and the emerging rapid DNA analysis systems.