ABSTRACT

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Title: Adhesion Characterization to Improve Trace Explosives Detection Using Mesostructured Polymers
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The catastrophic results of undetected improvised explosive devices (IEDs) are undeniable. During the fabrication, concealment, and transport of IEDs, residual amounts of explosive material are transferred onto clothes, luggage handles, and other surfaces. Current screening practices to detect these residues, such as contact sampling, often do not adequately detect a potential threat before it reaches a target area. As such, there is a critical need to improve contact sampling techniques through the development of fundamental structure-property-performance metrics such that the next generation of detection materials can be synthesized and implemented to achieve improved performance. The goal of this work, using experimental and computational techniques, is to establish design considerations that will lead to a particle trap that offers unprecedented performance and reliability for trace explosives detection. These drop-in replacement traps will be mesostructured polymers.

Here, three aspects of trap-explosive interactions have been examined. First, the interfacial properties of energetic materials were determined via contact angle measurements and compared to other determination methods. These interfacial properties strongly influenced the ability of an energetic particle to adhere to a trap. The energetic materials analyzed here will likely behave in a similar manner; therefore no special design considerations will need to be made for the different materials. Second, the

influence of mesoscale surface features on adhesion of microparticles was examined computationally. This model elucidated the importance of where the particle makes contact with a mesostructure and the independence of van der Waals forces generated by each mesostructure. To improve particle adhesion to the mesostructured swab, particle contact with the pillar face of mesostructures should be emphasized in the design. Third, representative chemical functionalities were evaluated in order to observe their effect on adhesion of energetic particles. Resolving the role that surface chemistry played in the adhesion of energetic materials allowed for surface functionalization of traps to increase adhesion. From this work, electron donating functional groups were identified as a leading class of chemical moieties to increase adhesion between detection surfaces and common energetics. Ultimately, the design criteria established here will, for the first time, enable the rational design of energetic particle collection materials based on interfacial phenomena.