OSAC Research Needs Assessment Form

Title of research need: Fundamental research into mechanism of particle formation

Keywords: GSR, particulate formation, lead-free ammunition, primer residues

Submitting subcommittee(s): GSR **Date Approved:** 11/28/16

(If SAC review identifies additional subcommittees, add them to the box above.)

Background information:

1. Description of research need:

There is a lack of knowledge in the field that describes the mechanism or particle formation as a function of barrel temperature and pressure (functions of ammunition, weapon, etc.). As a result, unusual or unexpected particulates are seen that are difficult to understand or assign sources. A recent example are particulates that contain barium and aluminum that are occasionally observed with shotgun discharges. Better understanding of the chemistry and physics of firearm-related particulates would be valuable in such cases and would add to the scientific foundation of the discipline.

2. Key bibliographic references relating to this research need:

[1] R. Y. Zhang, G. H. Wang, S. Guo, M. L. Zarnora, Q. Ying, Y. Lin, W. G. Wang, M. Hu and Y. Wang. Formation of Urban Fine Particulate Matter. *Chem. Rev.* **2015**, *115*, 3803.

[2] A. Nzihou and B. R. Stanmore. The Formation of Aerosols During the Co-Combustion of Coal and Biomass. *Waste Biomass Valorization.* **2015**, *6*, 947.

[3] T. L. Jensen, J. F. Moxnes, E. Unneberg and O. Dullum. Calculation of Decomposition Products from Components of Gunpowder by Using Reaxff Reactive Force Field Molecular Dynamics and Thermodynamic Calculations of Equilibrium Composition. *Propellants Explosives Pyrotechnics.* **2014**, *39*, 830.

[4] P. Kumar, L. Pirjola, M. Ketzel and R. M. Harrison. Nanoparticle Emissions from 11 Non-Vehicle Exhaust Sources - a Review. *Atmos. Environ.* **2013**, *67*, 252.

[5] R. Gauriot, L. Gunaratnam, R. Moroni, T. Reinikainen and J. Corander. Statistical Challenges in the Quantification of Gunshot Residue Evidence. *J. Forensic Sci.* **2013**, *58*, 1149.

[6] M. I. Szynkowska, A. Parczewski, K. Szajdak and J. Rogowski. Examination of Gunshot Residues Transfer Using ToF-SIMS. *Surf. Interface Anal.* **2013**, *45*, 596.

[7] J. F. Moxnes, T. L. Jensen, E. Smestad, E. Unneberg and O. Dullum. Lead Free Ammunition without Toxic Propellant Gases. *Propellants Explosives Pyrotechnics.* **2013**, *38*, 255.

[8] H. Ditrich. Distribution of Gunshot Residues - the Influence of Weapon Type. *For. Sci Int.* **2012**, *220*, 85.

[9] O. Dalby, D. Butler and J. W. Birkett. Analysis of Gunshot Residue and Associated Materials-a Review. *J. Forensic Sci.* **2010**, *55*, 924.

3a. In what ways would the research results improve current laboratory capabilities?

This research will not impact capabilities directly; rather its impact will be on foundational understanding and thus general improvement of practice and evidentiary value.

3b. In what ways would the research results improve understanding of the scientific basis for the subcommittee(s)?

The mechanism of particulate formation in general is reasonably well understood and documented for situations such as environmental particulates formed from diesel exhaust and atmospheric particulate formation. Similar studies are needed in the forensic context and for GSR. Understanding how GSR forms will facilitate predictive modeling that can be used as primer formulations change and evolve. This knowledge will also assist in flagging potential false positives and false negatives that could be ruled out based on the fundamental knowledge of particulate formation in the context of firearms.

3c. In what ways would the research results improve services to the criminal justice system?

Such knowledge will solidify the scientific foundations of GSR analysis and lend greater evidentiary power to GSR analysis.

4. Status assessment (I, II, III, or IV): I

	Major gap in current knowledge	**Minor** gap in current knowledge
No or limited current research is being conducted	**I**	**III**
Existing current research is being conducted	**II**	**IV**

This research need has been identified by one or more subcommittees of OSAC and is being provided as an informational resource to the community.

Subcommittee Approval date: 11/21/16

(Approval is by majority vote of subcommittee. Once approved, forward to SAC.)

SAC

1. Does the SAC agree with the research need? Yes No ◯

2. Does the SAC agree with the status assessment? Yes No ◯

If no, what is the status assessment of the SAC:

Approval date: 11/28/16

(Approval is by majority vote of SAC. Once approved, forward to NIST for posting.)