Q: Could piezoMEMS devices be made on SiC substrates?
A: Yes and there are examples in the literature.

Q: Would you consider reducing the cost of SiC, GaN or diamond substrates responsive to this BAA since the topic is substrate agnostic and accepting a wide range of conventional substrates?
A: The goals outlined in the topic are explicitly aimed at piezoelectric MEMS processes and relevant dielectric and piezoelectric material properties.

Q: Although the BAA calls out AlN and PZT piezoelectric materials as examples, are other piezoelectric materials such as SiC or quartz also of interest if they can be integrated with arbitrary large substrate as shown in Fig. 1 of the BAA? In other words, can the BAA be interpreted for looking for PDKs for integrating arbitrary piezoelectric resonators on arbitrary substrates?
A: 1) Other materials can be considered if they can meet the metrics outlined in the topic. 2) The PDK is envisioned to be general and applicable to a wide variety of devices.

Q: For a DP2 proposal, in order to satisfy the Phase I metrics, does a process need experimental demonstration with 150 - 300 mm substrates, or can previous process development with smaller substrates be used for satisfying the Phase I metrics with the scale-up proposed for DP2?
A: For a DP2, the metrics outlined in Phase 1 including the substrate size should be demonstrated.

Q: Is it possible to list d33, d31, and e33,f metric values that could be used as a substitute in place of e31,f in the phase 1 and 2 metrics tables?
A: A value for d31 can be converted to an e31,f value. If providing this calculation, please provide what elastic compliance values are used for the calculation. Additional piezoelectric coefficients can be used.

Q: For the metric on number of substrates, does a seed layer on a substrate count as a separate substrate? For example, silicon-on-insulator-on-Si seems to be different from Si. Would, for example, Al on quartz also be different from quartz? Also, would AlGaN-on-Si be considered different than Si?
A: A seed layer for growth of the piezoelectric layer would not be considered a separate substrate.

Q: Does substrate-agnostic growth need to be demonstrated for both PZT and AlN, or only one of the two?
A: Substrate-agnostic growth needs to be demonstrated by one piezoelectric material that satisfies all requirements on the property table.

Q: Is it permissible to grow a piezoelectric material other than PZT or AlN?
A: Other materials may be proposed as long as they can plausibly satisfy all material requirements as laid out in the properties table.

Q: Are there any special considerations for proposers who can fill out rows in the materials property table before the start of phase 1?
A: The material properties table must be filled out by the end of phase 1, there are no additional considerations for data in-hand prior to the start of phase 1.

Q: Does the PI have to be a US resident or citizen?
A: The company needs to be a US company, but the PI does not need to be a citizen or resident. There are, however, limits on where they can be from if it's an ITAR topic. PIs usually have to have a H1B visa.

Q: Is it possible to list d33, d31, and e33,f metric values that could be used as a substitute in place of e31,f in the phase 1 and 2 metrics tables?
A: A value for d31 can be converted to an e31,f value. If providing this calculation, please provide what elastic compliance values are used for the calculation. Additional piezoelectric coefficients can be used.

Q: What are the limits, if any, on budget and timeline for phase 3?
A: There are no limits on budget and timeline for Phase 3; however, no SBIR funds are used for Phase 3 efforts.

Q: Is this award only for an SBIR or can it also go towards an STTR?
A: This specific topic is a SBIR. There is another topic in the call that is a STTR.

Q: Are non-US vendors allowed to be used?
A: The prime must be more than 50% US-owned - see 13 CFR § 121.702

Q: Can non-US entities be used as sub-contractors? If so, is there a cost percentage limit?
A: Yes, but they can't do more than 1/3 of the work for SBIR.

Q: Can the BAA be interpreted for looking for PDKs for integrating arbitrary piezoelectric resonators on arbitrary substrates?
A: The PDK is envisioned to be general and applicable to a wide variety of devices.

Q: What an expected number of piezolayer module wafers required in Phase III, 2-3 years after completing the Phase II? Tens, hundreds or thousands?
A: We don't have a specification for this requirement in Phase III.

Q: What will be the best wafer size for DARPA customers during the first 2-3 years in the Phase III, 150mm (6”) or 200mm (8”)?
A: We don't have a specification for specific wafer size in Phase III.

Q: Is it acceptable to use foreign entities for a few required steps such as depositing well-oriented Pt bottom electrodes or all has to be made-in-USA?
A: Yes within the limits specified in the SBIR restrictions.

Questions from the Phase 1 metrics table:

Q: Does the cross wafer and wafer-to-wafer composition variance refer to the material consistency across the wafer? Or does this refer to some electrical or acoustic performance variation?
A: Material consistency via the composition or stoichiometry Electrical and piezoelectric property variations are referred to the material property section of the metric table.

Q: Regarding the piezoelectric phase purity specification. We are not sure how this applies to aluminum nitride. Could we satisfy this requirement showing XRD scans at various point across the wafer?
A: Phase purity can be shown via XRD scans.

Q: Regarding dielectric constant. The range is defined as 10-2000. However, the typical literature value of aluminum nitride is just under 10 (around 9.8). Is this sufficient? Can 9.85 be rounded up to 10 and meet criteria?
A: These values can be rounded up to 10.

Q: For the residual stress metric of +/- 500MPa, it is written as average value per layer. Can we simply report the residual stress of each individual level of our resonator stack?
A: The metric table requires reporting each layer in the material stack.

Q: What is your purpose or intention in getting this PDK together. I ask because the design flow for MEMs usually starts with a multi-physics modeling and simulation platform - like Comsol or Ansys. From here, the design intent is translated into the physical geometries that go to the fab. The layers and process steps for the MEMs process itself are quite simple enough that they don't pose adequate difficulty.
A: Our purpose is in the topic description.

Q: You do specify that some of the physical parameters like substrate properties and piezocrystal orientation should be in the PDK. Does this mean that you envisage this PDK to be able to interface with one of the multi-physics simulators? In integrated circuit PDKs, for instance, the process parameters are not directly present in the PDK. What is present are transistor characteristics - and these are only at the layers where the schematic to simulator software layers. When the design moves to the physical layers or mask geometries, there is no additional need to carry this information - as this information is not useful.
A: There is no specification in the metrics for a software simulator.
Q: Are you expecting that the PDKs will enable you to fabricate the same design - without any alteration on multiple fabs? Usually in the integrated circuit processes, some changes may be needed (even though the circuit may appear the same) when a design is ported from one fab to the other. This is also the case when designs are on the same process node (for instance, during a design ported from 0.18um design from an Analog-Devices process to a TSMC process, there were some design changes made to accommodate the difference in fab processes).

A: There is no specification that the process description and design documents is required to be ported between multiple facilities.

Q: Do you have any commercial piezo-mems fabs in mind when you put this BAA out?
A: No