PROSPECTS AND ISSUES OF NANOMATERIALS USE IN MICROELECTRONICS

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Background & Motivation

- NanoStreeM
  - Environmental, Safety, and Health (ESH) risks of nanomaterials cannot be derived from their bulk properties
  - Precautionary approaches in order to avoid exposure
  - Promote good practices, identify gaps in methodologies, and support risk assessment to protect human health
- Acquire a comprehensive overview on the utilization and technological issues of particulate nanomaterials in current and future semiconductor manufacturing

Key benefits of nanomaterials

- Nanomaterials have proven capabilities for ultimately scaled or post-silicon devices due to 0D, 1D, and 2D nanosize effects \( \Rightarrow \) nanowire transistors
- Nanomaterials modify matrix (bulk) materials to give enhanced performance
  - Physical properties \( \Rightarrow \) low-k dielectrics
  - Processing \( \Rightarrow \) high-NA immersion litho
- Improve manufacturability as process medium \( \Rightarrow \) CMP

Integration of particulate nanomaterials

- Application of nanoparticle powders and dispersions
  - Functional fillers
  - Dispersions
- Preparation from bulk or direct growth
- Unintended release during deposition, etching, waste treatment, end-of-life

Summary

- Particulate nanomaterials already in use in process media, packaging, and assembly
- Use cases can guide introduction to other areas

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