Standardization: Advanced Materials & Advanced Technologies

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ADVANCED MATERIALS VIRTUAL WORKSHOP

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Advanced Materials

- Integral Part of Innovation, society, sustainability
- Constantly created, applied and conventionalized (and regulated)
- Todays and tomorrow’s New Substances (chemicals/materials)!

Advanced Materials change with time…

PAST

Steel

PRESENT

e.g., Graphene Composites

FUTURE

??????

What was ‘advanced’ is no longer ‘advanced’ …

But how do you Standardize a Moving Target?

Practically, there is a need to focus on what's doable and important.

-Optimization of limited resources
-Learnings and overlap from Nanotechnologies

Similarities: Nanotechnologies and Advanced Materials

- Huge Technical Benefits of Societal Importance
- Rapidly evolving Research and Development Landscape
- Diverse industries involved
- Growing utility and Applications
- Questions about safe management practices
- Potential to behave different than “typical” materials
- Questions about identification
- Often existing SDOs for end application/performance metrics

Differences: Nanotechnologies and Advanced Materials

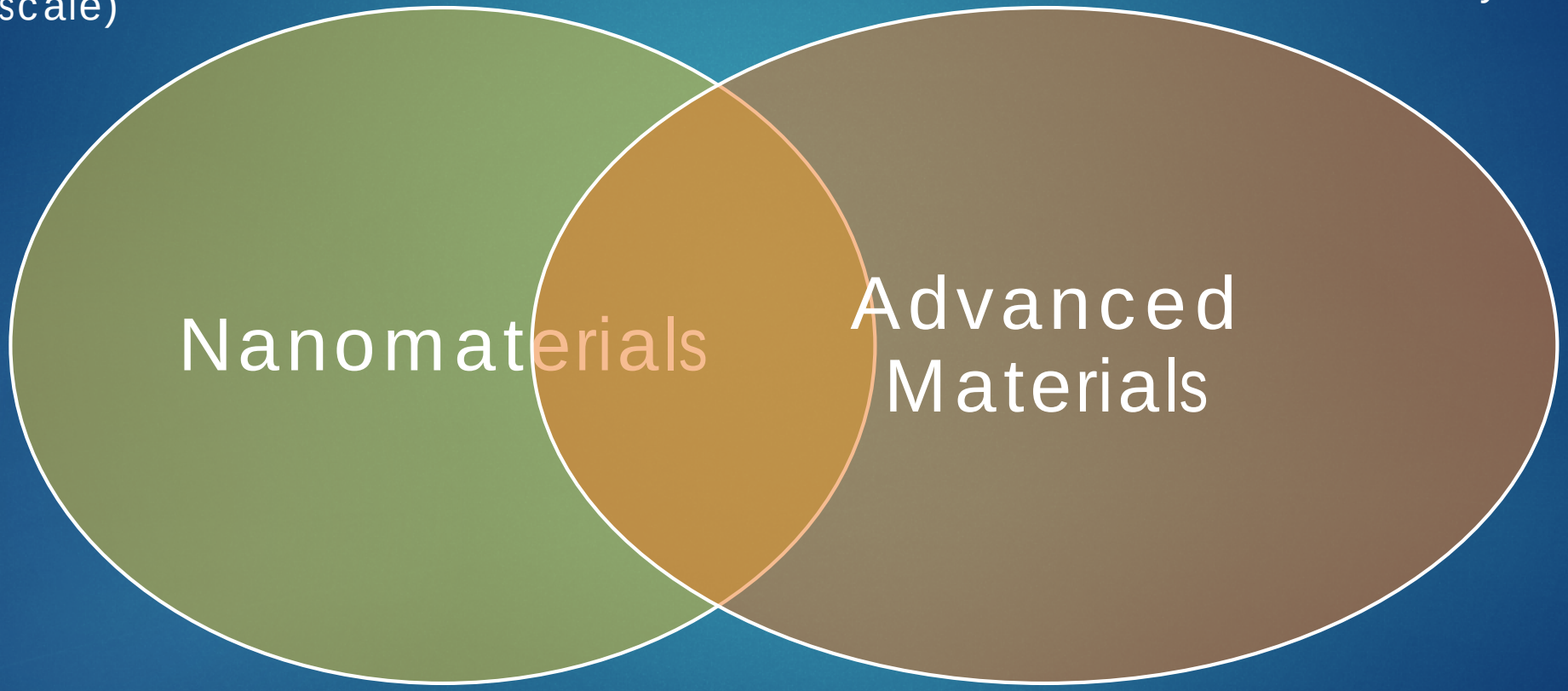
- Nanomaterials are defined by size, Advanced Materials by what they do…
  - Not all nanomaterials are advanced materials, and advanced materials are not all nanomaterials
- Wider physicochemical "box" for Advanced Materials
- "Advanced" status may depend on application space
  - "Advanced" in one industry/application but conventional in another
- Lifetime as an "advanced material" is limited

Overlaps & Distinctions

Colloidal Silica (nanoscale)

Metal Organic Frameworks

Novel Polymers, Metal Alloys



How standardization has benefited the advancement & commercialization of Nanotechnologies

- Terminology
- Measurement and Characterization
- Materials Specifications
- Health, Safety & the Environment
- Products and Applications
- Education & Workforce Development

Standardization & Facilitation of Trade: Nanotechnologies

- ISO TC 229: 98 Published Standards; 30 Standards under development
- ASTM E56: 15+ Active Standards
- Multiple standards across vertical committees

What is it?

Safe Use

Performance and Impact

Important process steps and characterization parameters

Reliable testing methods for measuring parameters and reporting

Enables:

Safe Development and Use

International technical knowledge sharing through common methods

Building blocks for workforce development

Worked to lower common barriers

Example: Graphene

- **Terminology**

  ISO/TS 80004-13:2017 - Nanotechnologies — Vocabulary — Part 13: Graphene and related two-dimensional (2D) materials

- **Measurement and Characterization**

  ISO/TS 21356-1:2021- Nanotechnologies — Structural characterization of graphene — Part 1: Graphene from powders and dispersions

- **Materials Specifications** (ongoing activity)

- **Health, Safety & the Environment**

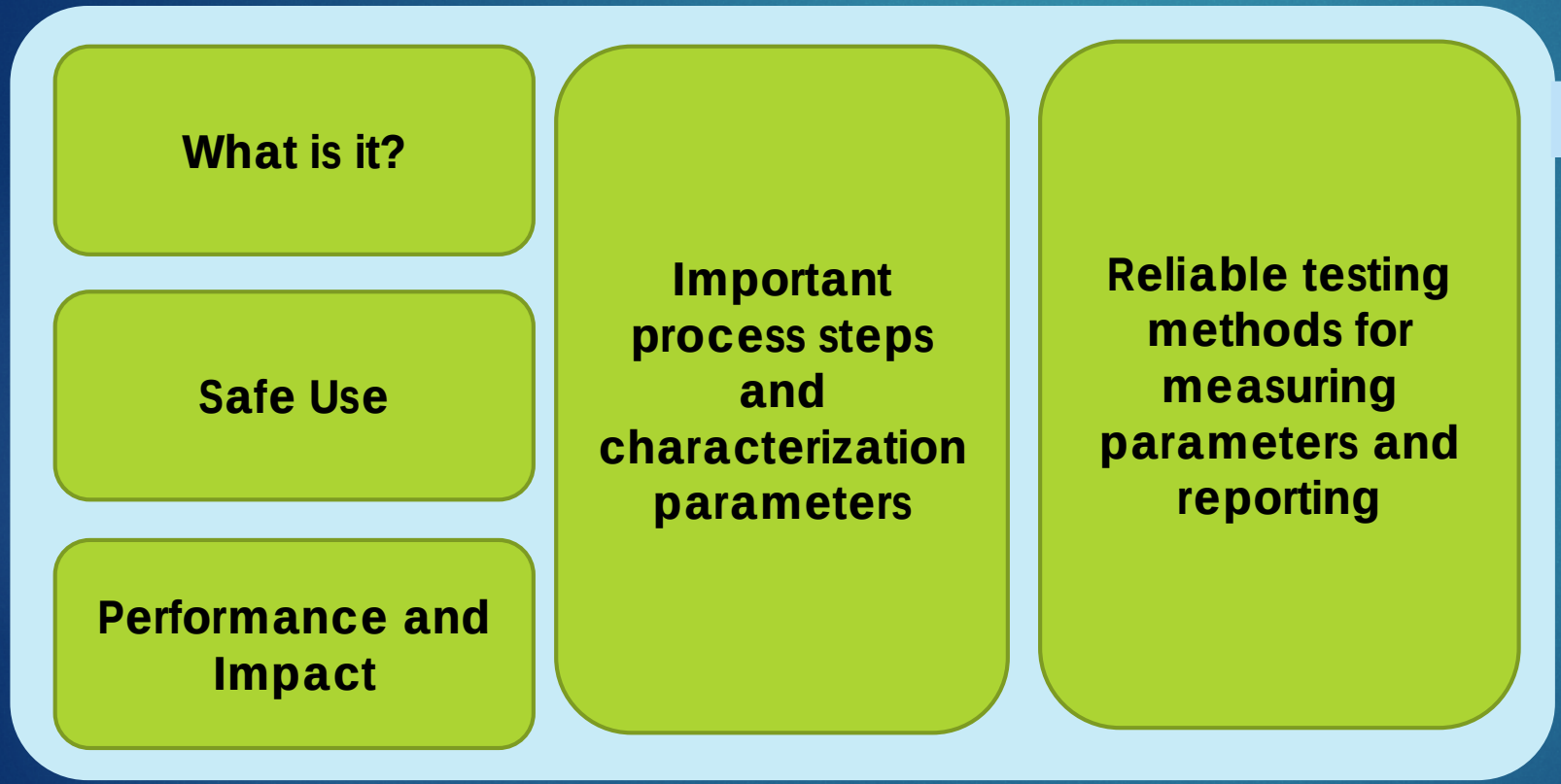
  ISO/29701:2010 - Nanotechnologies --Endotoxin test on nanomaterial samples for in vitro systems -- LAL Assay

  ISO 10808:2010 – Nanotechnologies --Characterization of nanoparticles in inhalation exposure chambers for inhalation toxicity testing

  ISO/TS 19337:2016 - Nanotechnologies -- Characteristics of working suspensions of nano-objects for in vitro assays to evaluate inherent nano-object toxicity

(Plus several other general methods for nano-object assessment see: https://www.iso.org/obp)
Also application specific measurements in IEC & elsewhere… Rigor? Critical Mass?

Standardization & Facilitation of Trade: ~~Nanotechnologies~~ Advanced Materials?



Enables:

Safe & Sustainable Development and Use

International technical knowledge sharing through common methods

Building blocks for workforce development

But how do you Standardize a Moving Target?

Where to Focus?

- What's been done
- What are the priorities
- What needs to be done?

Role of Horizontal versus Vertical SDCs

Vertical

Application or Device Specific

Examples:

- ISO/TC 4 Roller Bearings
- ISO/TC 79 Light Metals & their Alloys
- ISO/TC 206 Fine Ceramics

Horizontal

Broadly Impactful Subject matter

Examples:

- ISO/TC 43 Acoustics
- ISO/TC 207 Environmental Management
- ISO/TC 229 Nanotechnologies

Avoiding Double-work & Confusion

- Many standards developed in vertical committees are also relevant for advanced materials (e.g., performance standards).
- Many nanotechnology standards may be equally valid for some advanced materials.
- What are the most important aspects of advanced materials that need to be standardized?
- What is too early for standardization?
- What is ready for standardization?
- Which existing standards could be modified to account for advanced materials?

Some Standards from TC 229 that may be applicable to some Advanced Materials

ISO/TR 22293:2021 - Evaluation of methods for assessing the release of nanomaterials from commercial, nanomaterial-containing polymer composites

ISO/TS 23650:2021 - Nanotechnologies - Antimicrobial textiles - Specifications and performance

ISO/TS 21236-2:2021 - Nanotechnologies — Clay nanomaterials — Part 2: Specification of characteristics and measurements for clay nanoplates used for gas-barrier film applications

ISO/TS 80004-6:2021 - Nanotechnologies — Vocabulary — Part 6: Nano-object characterization [Replaces ISO/TS 80004-6:2013]

ISO/TR 12885:2018 – Nanotechnologies – Health and safety practices in occupational settings [Replaces ISO/TR 12885:2008]

ISO/TR 21386:2019 – Nanotechnologies - Considerations for the measurement of nano-objects and their aggregates and agglomerates (NOAA) in environmental matrices

ISO/TR 19057:2017 - Nanotechnologies — Use and application of acellular in vitro tests and methodologies to assess nanomaterial biodurability

ISO/TR 18637:2016 – Nanotechnologies – Overview of available frameworks for the development of occupational exposure limits and bands for nano-objects and their aggregates and agglomerates (NOAAs)

ISO/TR 16196:2016 - Compilation and description of sample preparation and dosing methods for engineered and manufactured nanomaterials

ISO/TR 17302:2015, Framework for identifying vocabulary development for nanotechnology applications in human healthcare

ISO/TS 18110:2015 - Nanotechnologies - Vocabularies for Science, Technology and Innovation Indicators

ISO/TS 80004-1:2015 – Nanotechnologies – Vocabulary – Part 1: Core terms [Replaces ISO/TS 80004-1:2010]

ISO/TS 12901-2:2014 – Nanotechnologies – Occupational risk management applied to engineered nanomaterials – Part 2: Use of the control banding approach

ISO/TR 16197:2014 - Nanotechnologies -- Compilation and description of toxicological screening methods for manufactured nanomaterials

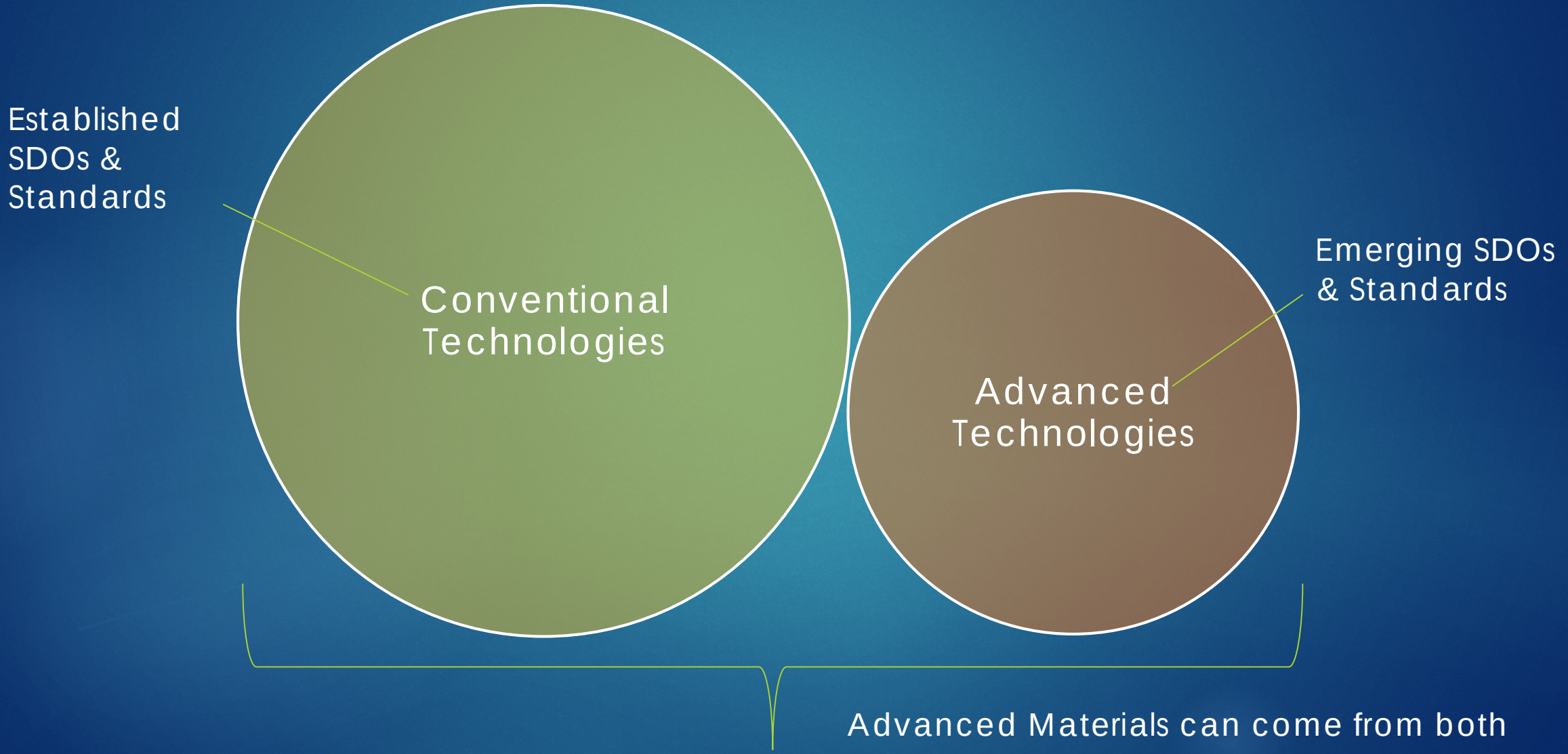
ISO/TS 13830:2013 – Nanotechnologies – Guidance on voluntary labelling for consumer products containing manufactured nano-objects

Learnings from Nanotechnology

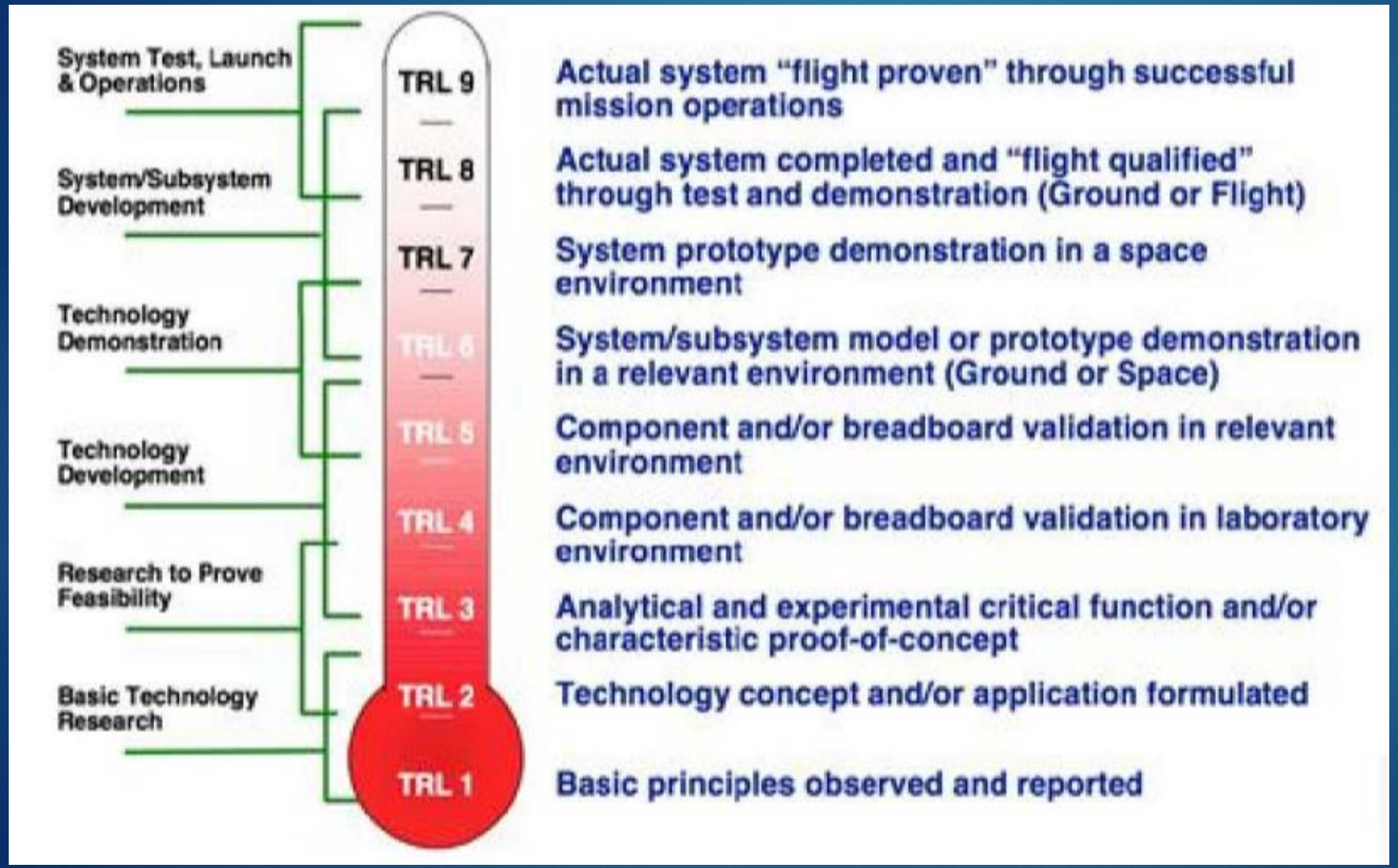
- **Expectations of widespread "novel & unique" properties were not realized**
  - "Novel & unique" properties became explainable & more predictable with time, knowledge evolution
    - Small subset of nanomaterials than common across the size range
  - Existing paradigms (e.g., chemical safety, aerosol & colloid behavior) adaptable for nanomaterials
  - However, measurement approaches and considerations can be more complex
- **General strategies often require system & purpose specific modifications**

Much of the "opportunities" and "concerns" for nanomaterials in retrospect are from a subset of "advanced materials"

Advanced Materials & Technology



Technology Readiness Levels



Higher Priority
"still too early?"

Standardization Need

Lower Priority
"too early?"

Readiness Levels Important to Trade & Commerce

Technology Readiness

- Can it be done?

Manufacturing Readiness

- Can it be made economically at scale?

Market Readiness

- Will they adopt it?

Regulatory Readiness

- Can we accept it?

Significant Potential for Impact when High

Lower Risk when high

Societal Drivers for Advanced Materials …

Commitments to UN Sustainability Goals

-Advanced Materials are essential to progress

Decision making is based on both perceived and actual risks

- Uncertainty in regulatory compliance or acceptance matters

Are there gaps and risks that standardization can help address to enable to deployment and adoption of the best solutions?

Concluding Remarks

- Drivers for standardization of Advanced Materials are similar to those for nanotechnologies almost two decades ago
- Existing and overlapping standards exist that cover some forms of advanced materials (e.g., various nanomaterials and vertical committee performance-based standards)
- Prioritization of gaps needs to addressed to best serve the community
  - Could readiness levels and foresight driven by societal movements help in this area?
  - Which standards are needed and for what purpose?

Thank You!

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