


# The Materials Genome Initiative

## TechConnect World 2012

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White House Office of Science and Technology Policy





“To help businesses discover, develop, and deploy new materials twice as fast, we’re launching what we call **the Materials Genome Initiative**.

The invention of silicon circuits and lithium ion batteries made computers and iPods and iPads possible, but it took years to get those technologies from the drawing board to the market place. **We can do it faster.**”

-President Obama (6/11)









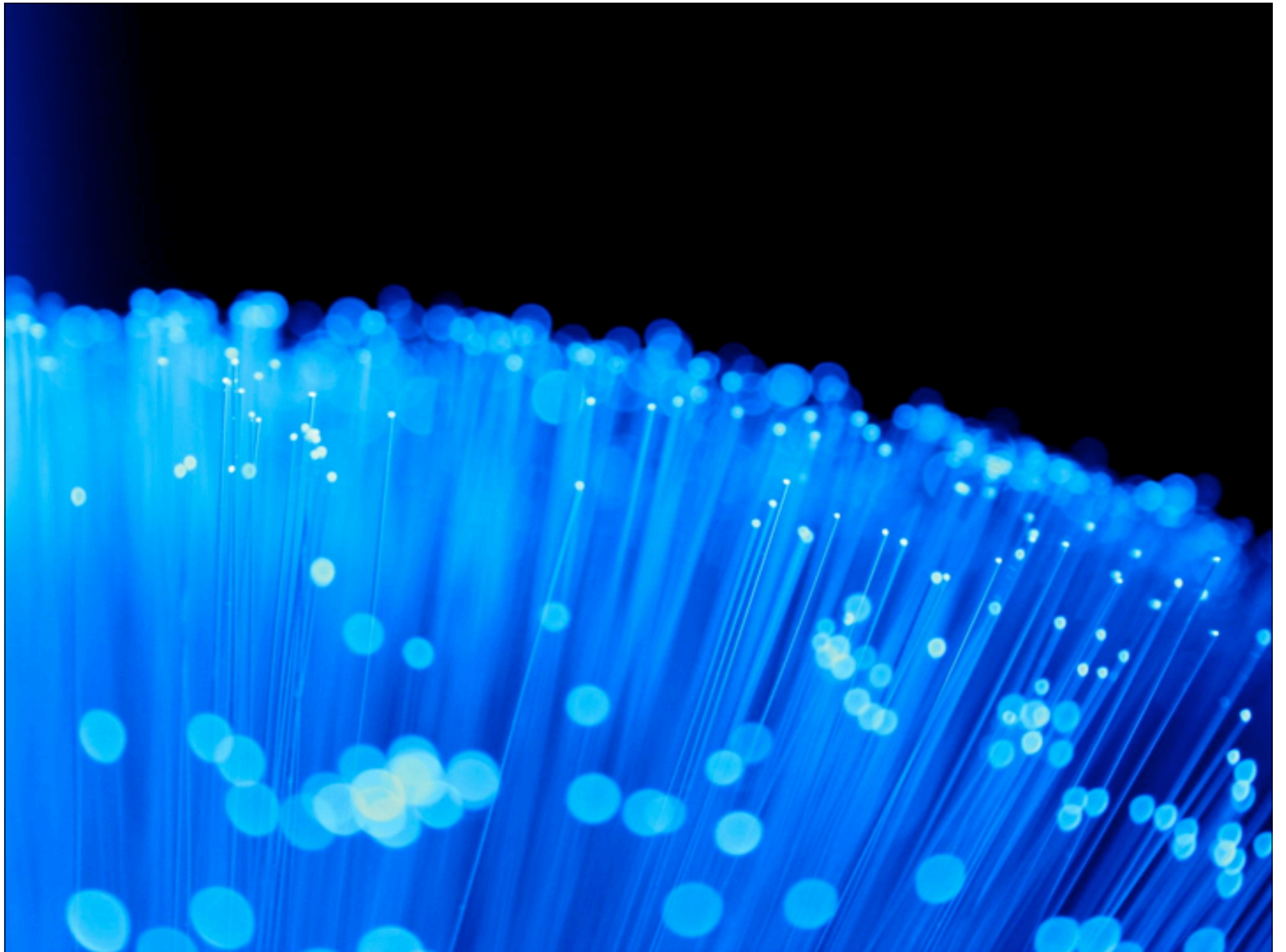














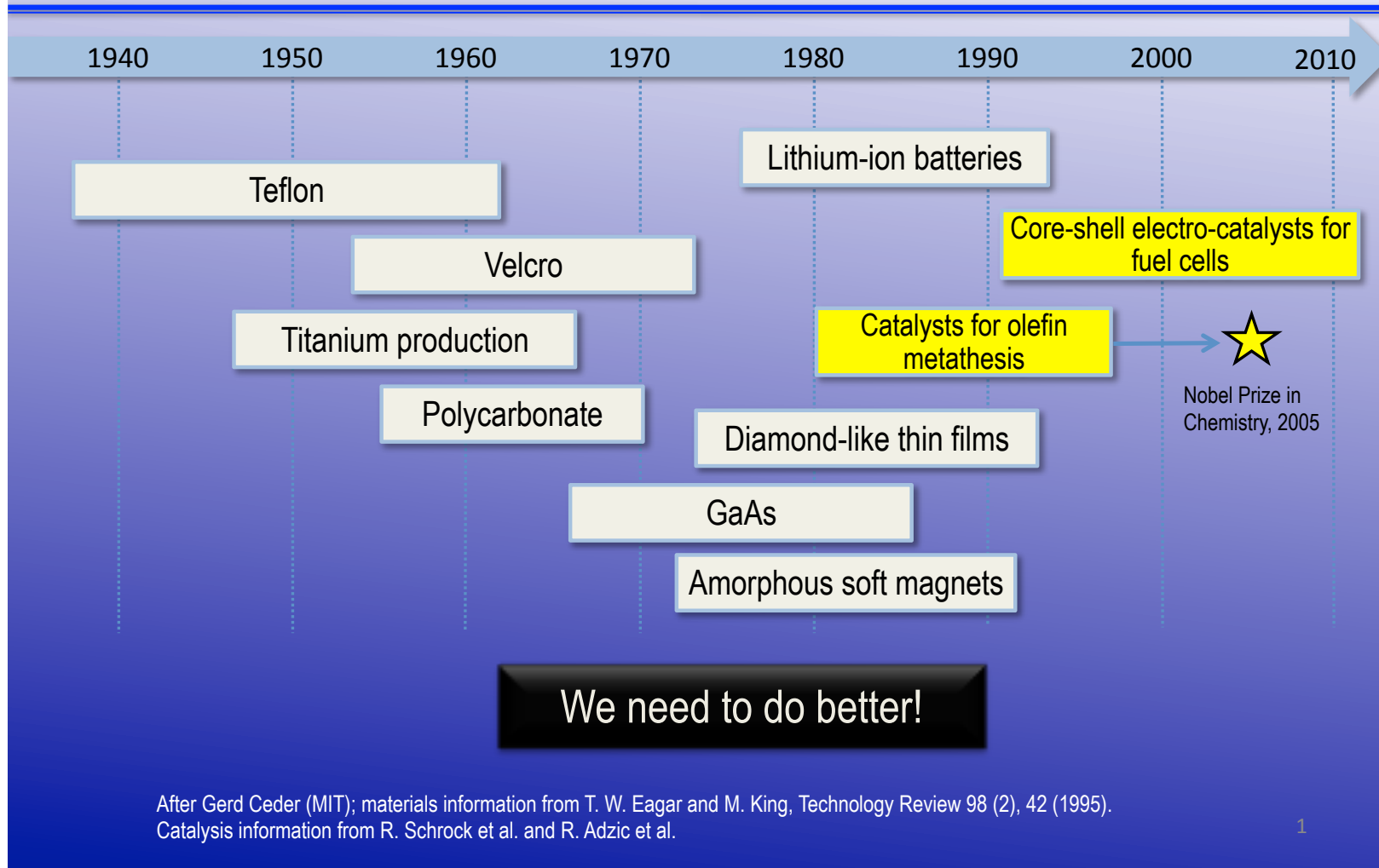








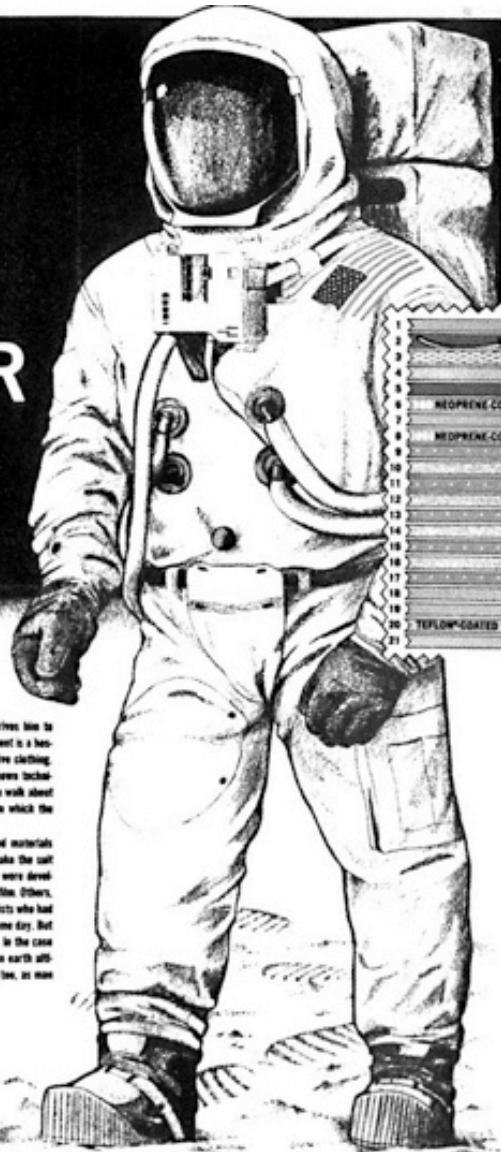
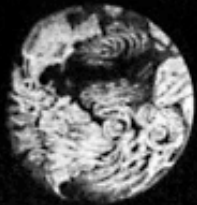
# Discovery to Application in the 20<sup>th</sup> Century



After Gerd Ceder (MIT); materials information from T. W. Eagar and M. King, Technology Review 98 (2), 42 (1995).  
Catalysis information from R. Schrock et al. and R. Adzic et al.



# THE 21-LAYER SPACE SUIT



1	NYLON
2	LYCRA
3	NOMEX
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Man designed man to inhabit the earth, but his will to know drives him to explore other environments, such as the moon. The lunar environment is a hostile one, and in order to survive there, man requires special protective clothing. Science and technology have worked together to develop a suit (known technically as the Lunar Extravehicular Mobility Unit) which enables man to walk about the moon. This poster explains the complex layers of material from which the space suit is made.

De Pont, the world's largest chemical corporation, developed materials used in 20 of the 21 layers in the space suit, although it did not make the suit itself. (3M Industries makes the suit.) But some of these materials were developed with the moon in mind. Some were new materials, like "Kapton" film. Others, such as nylon, were discovered more than thirty years ago by scientists who had no idea of the distance the results of their research would travel some day. But achievements in science are often put to use in unexpected places. In the case of the space suit, materials which De Pont had developed for use on earth ultimately found a place on the moon. We can expect to see them used, too, as man strikes out for outer space and farther planets.

## DuPont materials in Apollo moon suits were originally developed for earthbound use . . .

### NYLON

LAYER 1

Soft nylon fibers were only natural fibers till, linen, cotton, and wool, and man-made fibers extracted from wood pulp. Du Pont nylon, introduced in 1928, was an original accomplishment—a fiber made by man entirely from chemicals. It combines two very desirable properties—strength and durability—seen when made into the sheaves of stockings. It is used in the first layer of the space suit, next to the astronaut, as a lightweight "sweat shirt."



### VINYL TUBING

LAYER 2

This layer of the space suit is designed to help keep the astronaut cool. Water is circulated through a network of flexible vinyl tubing, much as blood is pumped through your body's veins, and capillaries. Similar kinds of vinyl tubing are used in laboratories to transfer fluids from one container to another.



### LYCRA®

LAYER 3

"LYCRA" SPANDEX FIBER

"Lyra", invented by De Pont, is a man-made fiber that has all the elastic qualities of natural rubber. It is stronger than natural elastic thread, but weighs one-third less and wears much longer. "Lyra's" flexibility and strength make it a good choice for a material to hold the cooling tubes close to the astronaut's body. You will find it most often in women's swim suits and undergarments.



### NOMEX®

LAYER 4

"NOMEX" NYLON TARS

De Pont scientists learned to make many types of nylon. "Nomex" is a high-temperature resistant nylon. It cannot be melted or melted prior to burning qualities. Its weight was to burning, it built into the liner itself and will not wear out or wash out. "Nomex" nylon is also used in making aircraft seats, in clothing for people who may not be able to protect themselves in case of fire, such as children and mental patients, and in an aircraft engine heat covers.



### NYLON COIL

LAYER 5

Cloned off from the vacuum of space by their protective suits, the astronauts must breathe. A network of elastic carbon oxygen to the astronaut from his back pack. These ducts are kept open and clear by spring-like coils made of a "Dylar" nylon mesh. This type of nylon coil is used to guarantee proper flow of life-giving oxygen to the life-support system, to assure uninterrupted flow of fuel from pump to gas tank.



### NEOPRENE-COATED NYLON

LAYERS 6, 7

Neoprene is a very special kind of synthetic rubber. It is not affected by heat, acid, alkalis, grease, oil, or even—used in liquid car-seal or seal through it. In the space suit, used to seal nylon, it acts as a barrier layer to help keep oxygen from a minimum. The most common use of this fabric on earth is in the life-support system that protects the astronaut's body, and for large inflatable structures.



### NYLON

LAYER 9

As you have indicated, nylon can be produced in a variety of forms. In layer 9, because weight for weight it is stronger than steel wire, it is used as a resistant tape. To hold the more layers beneath it in place. This same kind of nylon is used for seat belts in cars and airplanes.



### MYLAR®

LAYERS 8, 11, 12, 15, 17  
"MYLAR" POLYESTER FILM

De Pont began producing super-strong "Mylar" in 1954. It takes a force of 75,000 lbs. per square inch to pull apart a sheet of "Mylar" only one one-thousandth of an inch thick. It is used as the base material in balloons. In packaging such items as poultry and frozen "fish-in-the-bone" foods, and in electric motor insulation. In the space suit, two layers of aluminum-coated "Mylar" help to block off radiant heat from the sun, and hold body heat in to protect against the cold of space.



### DACRON®

LAYERS 10, 13, 14, 16  
"DACRON" POLYESTER FIBER

"Dacron" is a man-made fiber, used extensively in apparel and home furnishings. Some of you might be wearing garments made of "Dacron" right now. In the space suit, two layers of strong yet flexible "Dacron" polyester are alternated with the layers of "Mylar" in a kind of "sandwich" to protect the astronaut against heat and cold.



### KAPTON®

LAYERS 18, 19

"KAPTON" POLYIMIDE FILM

De Pont introduced "Kapton" in 1964. Two dimensional layers protect the astronaut from extremes in temperatures. 520° F. in some days to minus 250° F. in some nights. "Kapton" was chosen because it will not char, melt, or burn at high temperatures, even when in this at one one-thousandth of an inch. It was also used in the moon landing space ship to insulate 14 miles of wire. The world's "Kapton" is used in making motors for high-speed trains and wiring for aircraft.



### TEFLON®-COATED GLASS FIBER

LAYER 20

"TEFLON" TFE-FLUOROCARBON FINISH

"Teflon" TFE-fluorocarbon resin finish, used for so-called "non-stick" cookware, was a scientific serendipity. Discovered by De Pont scientists while at work on other research, in the compound space ship, 15 miles of wiring are covered with "Teflon" resin. For the space suit, glass fibers are coated with "Teflon," then woven into a fabric. This layer was designed to provide fire protection and to guard against high-speed dust particles.



### TEFLON®

LAYER 21

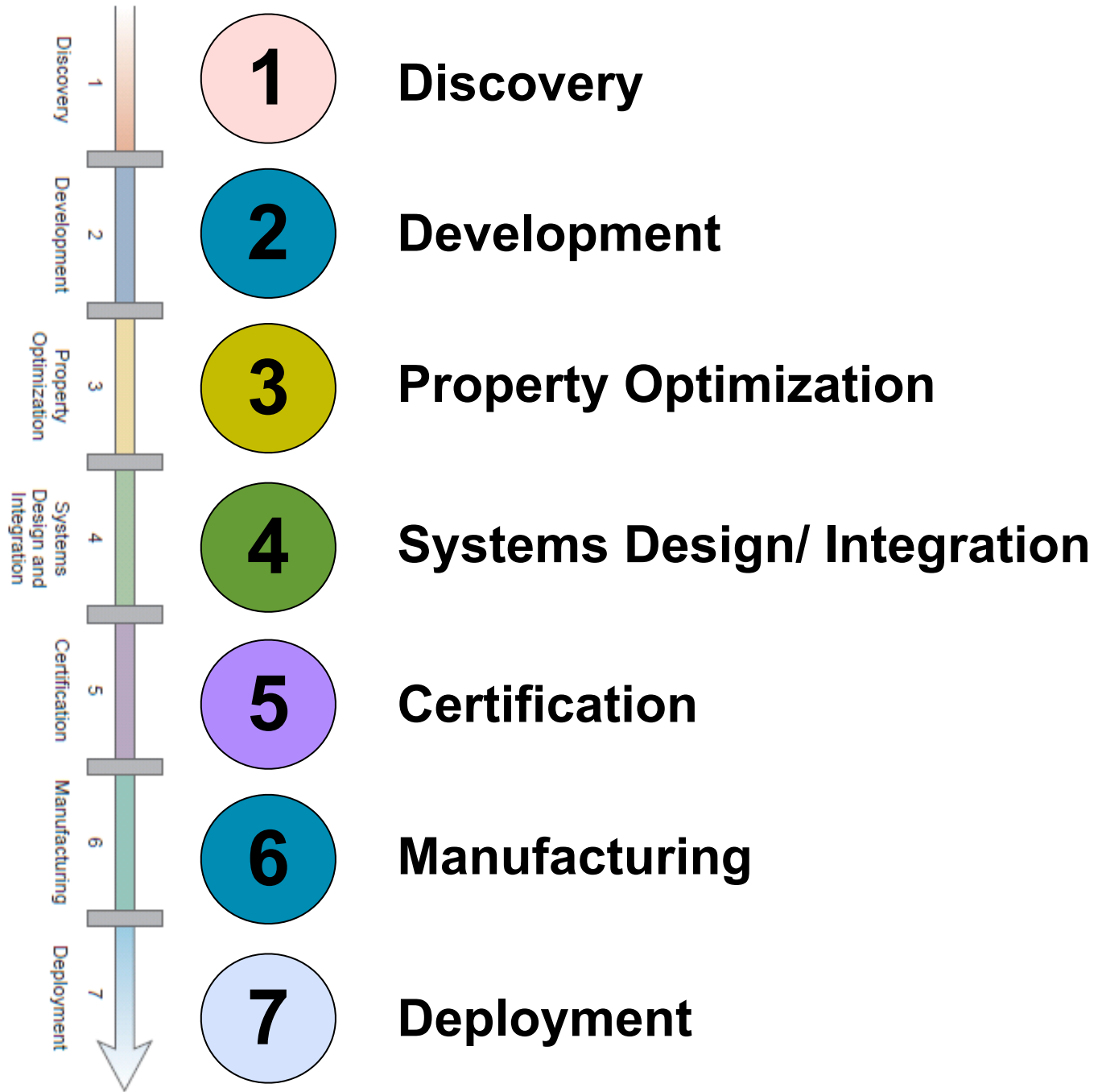
"TEFLON" TFE-FLUOROCARBON FINISH

Here the "Teflon" TFE-fluorocarbon resin is made into fibers and woven into a fabric of "Teflon." On earth, because it is almost totally friction-free, you'll find this fabric used in prosthetic bearings. In the moon, it is used as the outermost layer in every hard-wear part of the astronaut's suit, such as the gloves, boots, and shoelaces, to provide an abrasion-resistant surface. About 95% of the space suit is covered with this special fabric.





**... 2X faster & 2X cheaper**







# Cross-Cutting Themes – Top 4 List

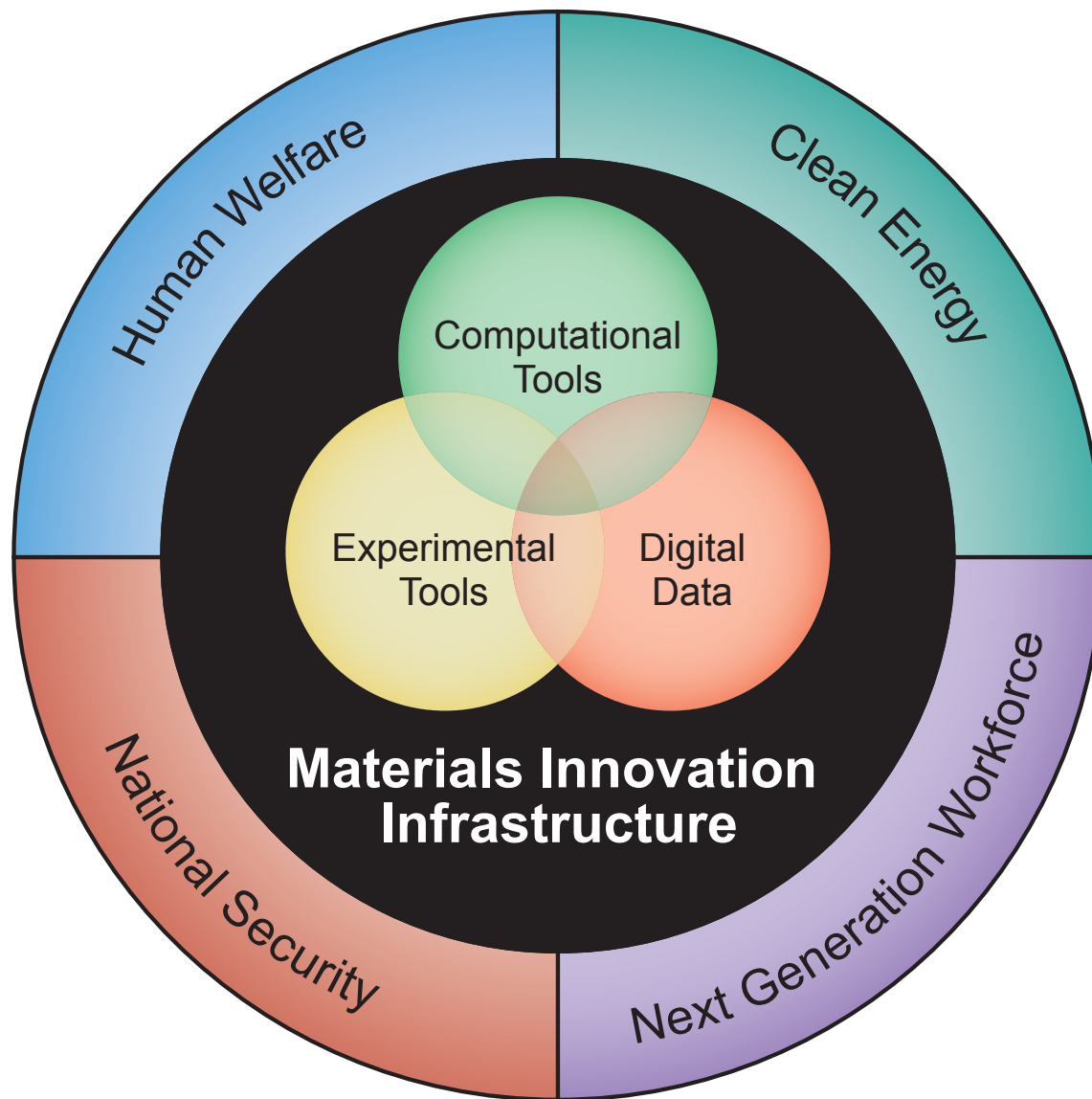
## All Hands on Deck

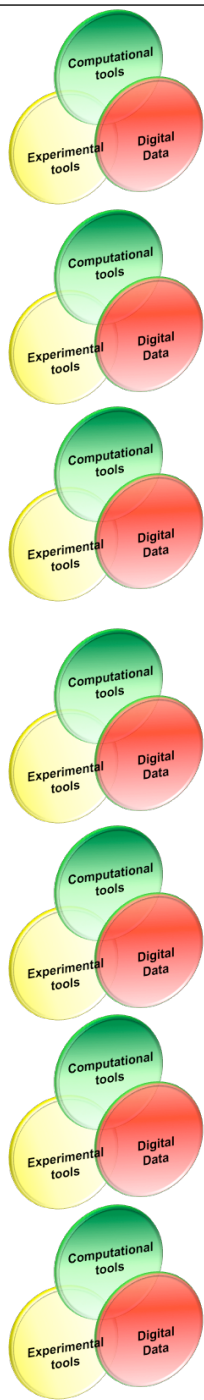
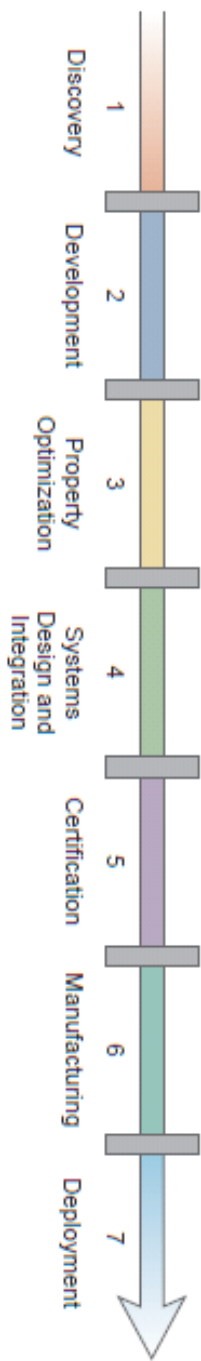
1. Incentivizing open data and access of tools
2. Structuring public-private partnerships
3. Driving innovation across computation, data informatics and experimentation
4. Moving the community to a different cultural norm



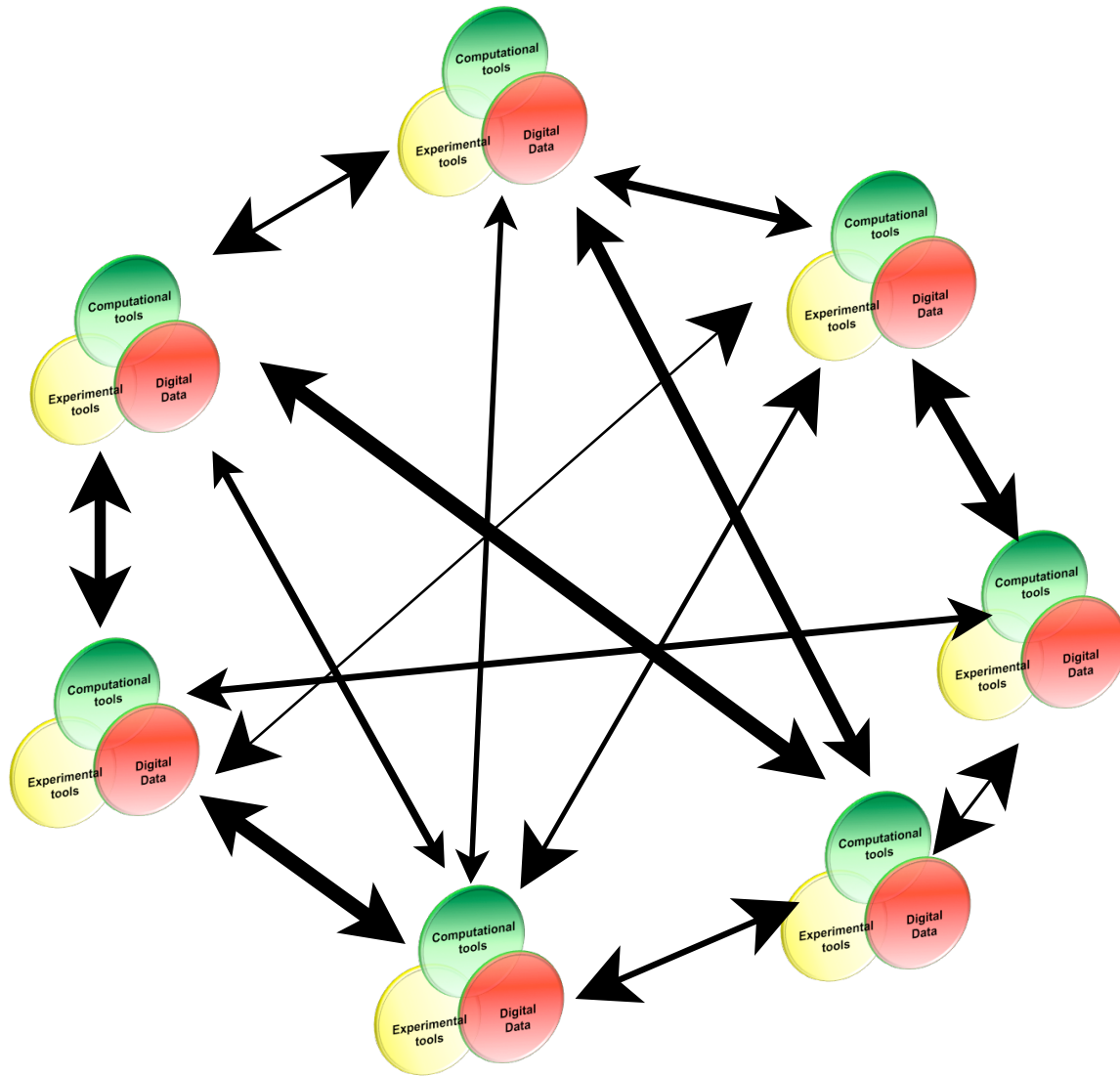


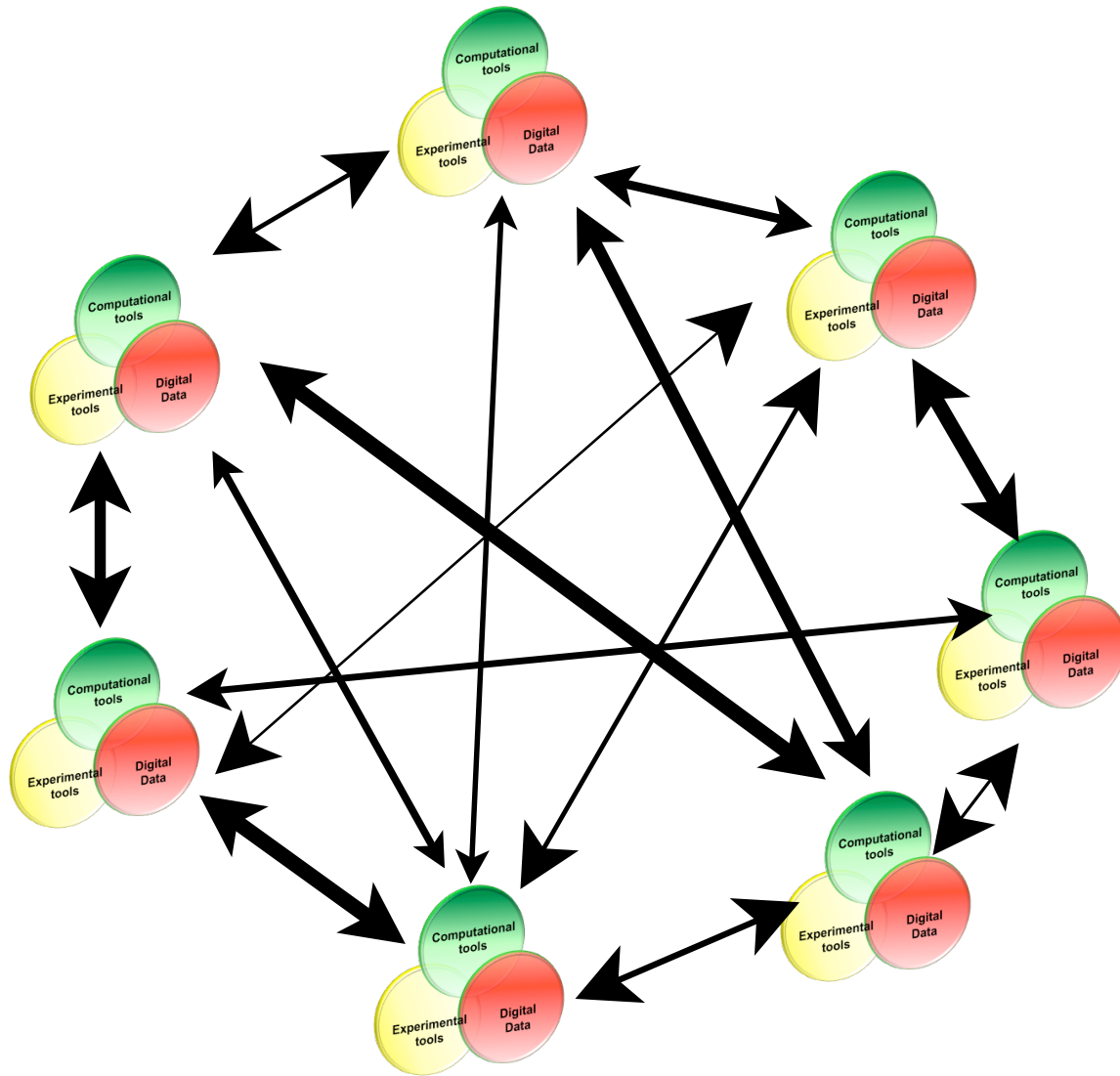
# The Materials Innovation Infrastructure



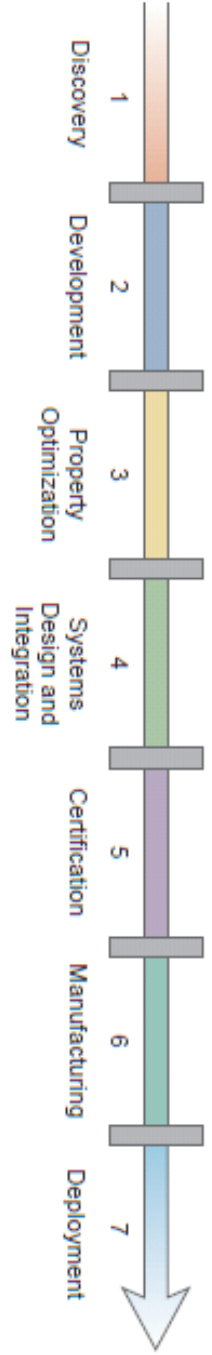
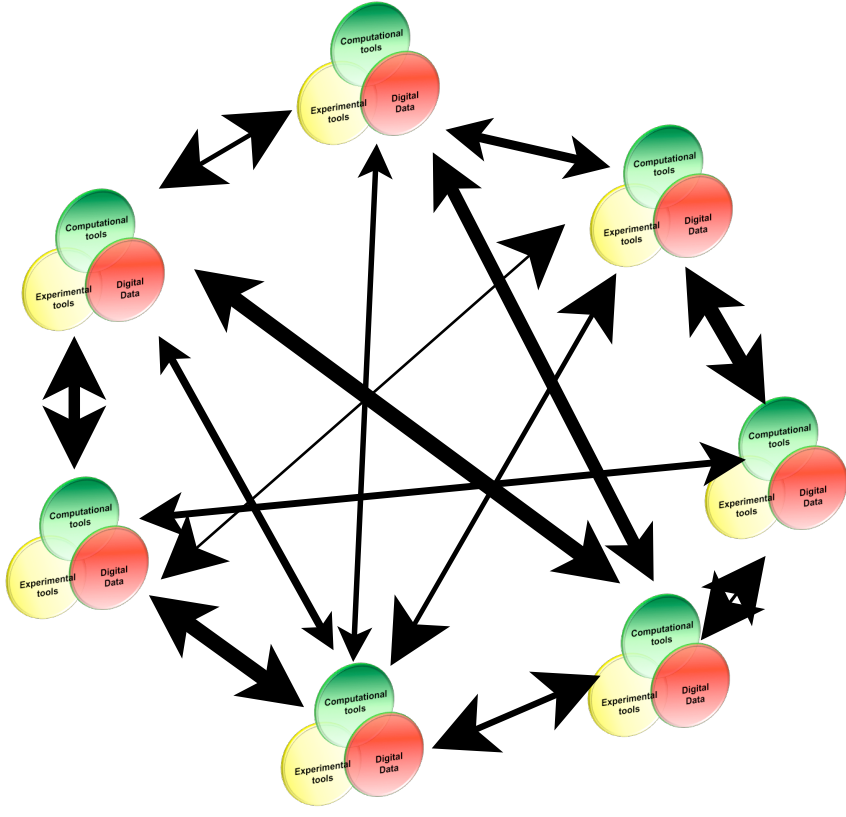




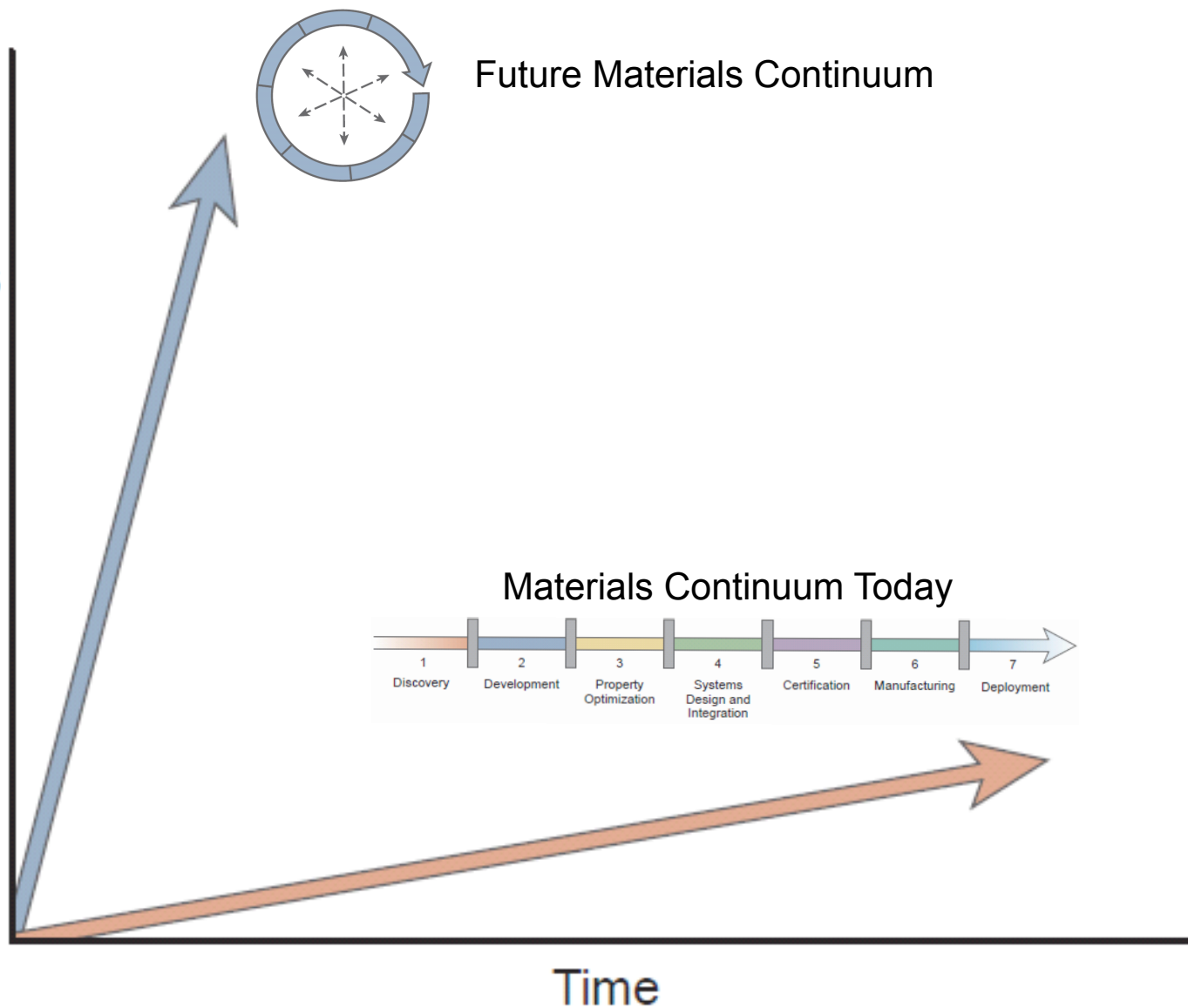








Number of  
New Materials  
to Market



# Achieving the Vision

## Accomplishments to Date

- Federal MGI activity in FY12 (DOE, NSF, DOD, NIST)
- Interagency workshop and White House event
- Leverage on existing Federal programs
- Interagency coordination and standing presence
- External stakeholder commitments
- Partnering with universities, professional societies, NGO's, AMP





# Achieving the Vision

## Where We Are Heading

- Roadmap of milestones, policies and R&D activity for FY13/ FY14
- Convening stakeholders to guide the movement
- Industry initiated commitments and activity
- University initiated commitments and activity
- Commitments from publishing community



# Call to Action

## All Hands on Deck

- Identify something specific for your community to participate
- Identify shared principles that might guide collaboration
- Data - pre-competitive sharing, access, informatics
- Scaling pockets of success
- Feedback to OSTP and Federal agencies

