9. Nanotechnology and materials field

9.1. Overview

(1) Overview of field

Nanotechnology is key science and technology for solving various problems in biology, information, the environment, and energy. In addition, the field is attractive as basic science that will bring unprecedented breakthroughs in nanometer-scale processing, molding, synthetic materials, and functions.

(2) The following points underlie the designation of important science and technology areas in the nanotechnology field.

- Historically, more than a few discoveries and inventions have been born from the serendipity of individual researchers, but at the other end of the spectrum, research with a goal (application) firmly in mind is also vital.
- Basic research is particularly important in the nanotechnology field, but at the same time, collaboration with industry must be further advanced. In addition, corporate laboratories need to address basic research, and they require further national government support to do so.
- As for technology areas, measuring technology, NEMS technology and other areas related to basics, fundamentals, and principles are particularly important. Expectations are high for the development of new industries such as NEMS and MEMS that are completely different from those that have supported precision processing until now.
- Regarding materials, needs-oriented research is important, but incubator and exploratory research has led to breakthroughs in areas such as fullerenes and carbon nanotubes as well.

(3) Policy proposals from the particulars of the area can be summarized as follows.

- Nanomaterials modeling simulation → human resources development
- Nano measurement and analysis technology → investment of human resources and funding in basic technology will be effective
- Nano processing, molding, and manufacturing technology → support for intellectual property rights, promotion of research exchange, and support for small and medium businesses
- Matter and materials origination, synthesis technology and process technology → collaboration and cooperation among multiple organizations
- New materials from nanolevel structure control → research to develop practical applications is essential
- Nano devices and sensors → university-centered research systems integrating industry
- NEMS technology → establishment of a joint-use center
- Environment and energy materials → advancement through effective use of nanomaterials
- Nanobiology → frameworks for organic collaboration among researchers
- Nanoscience for a safe and secure society → human resources development and accomplishment of international harmonization of relevant policies

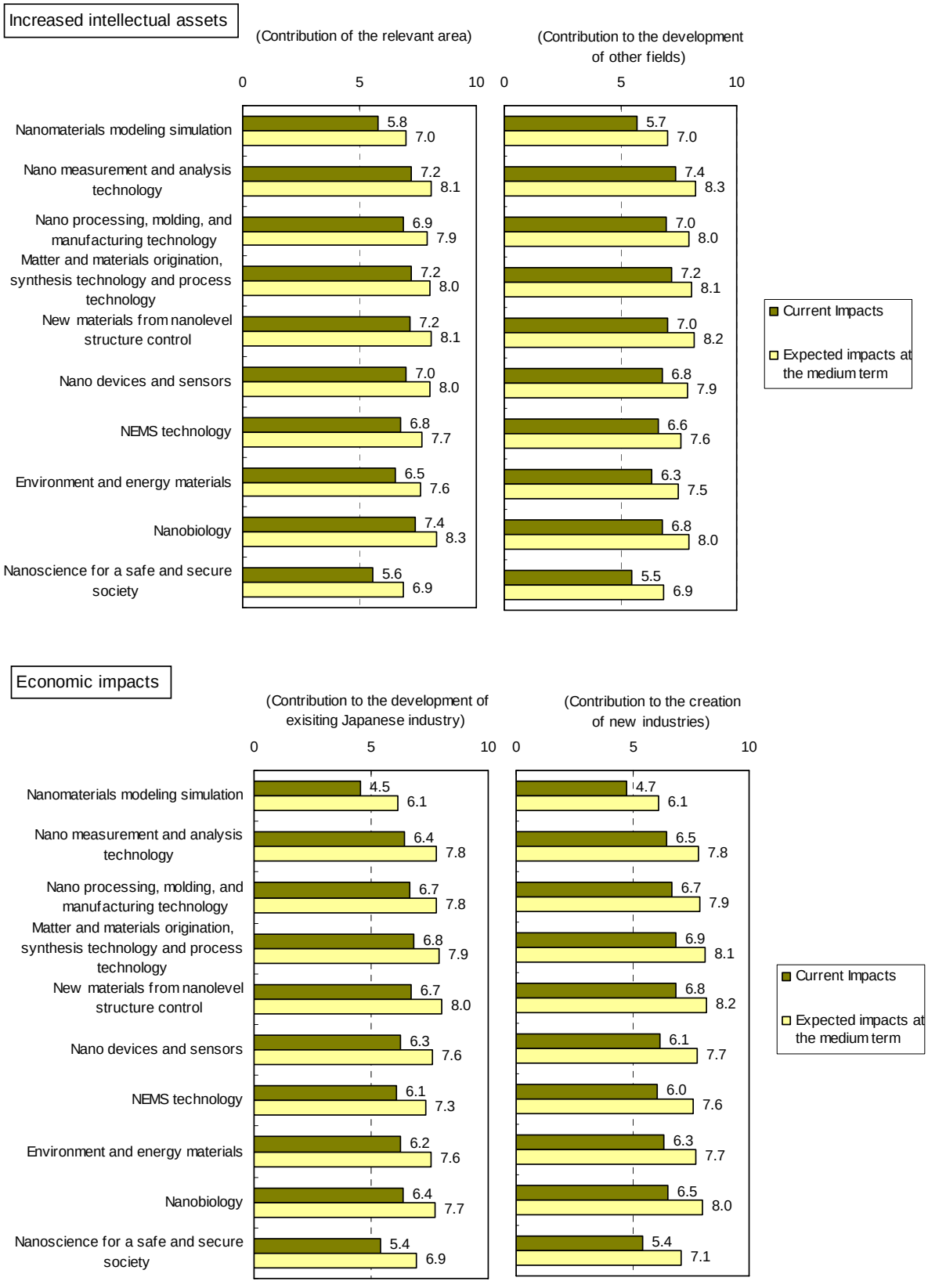
(4) Promotion policies

In the nanotechnology and materials field, many areas require much time from technological realization to social application. It is therefore vital that the national government develop a medium-term support system. Concretely, that vision must incorporate the creation of research infrastructure, including large-scale facilities, and human resources development and retention. It is essential that Japan lead the way in basic methods and principles and not fall behind. Investment and promotion policies to open new integrated science and technology fields based on nanotechnology and to increase Japan's strength in this already strong field are needed.

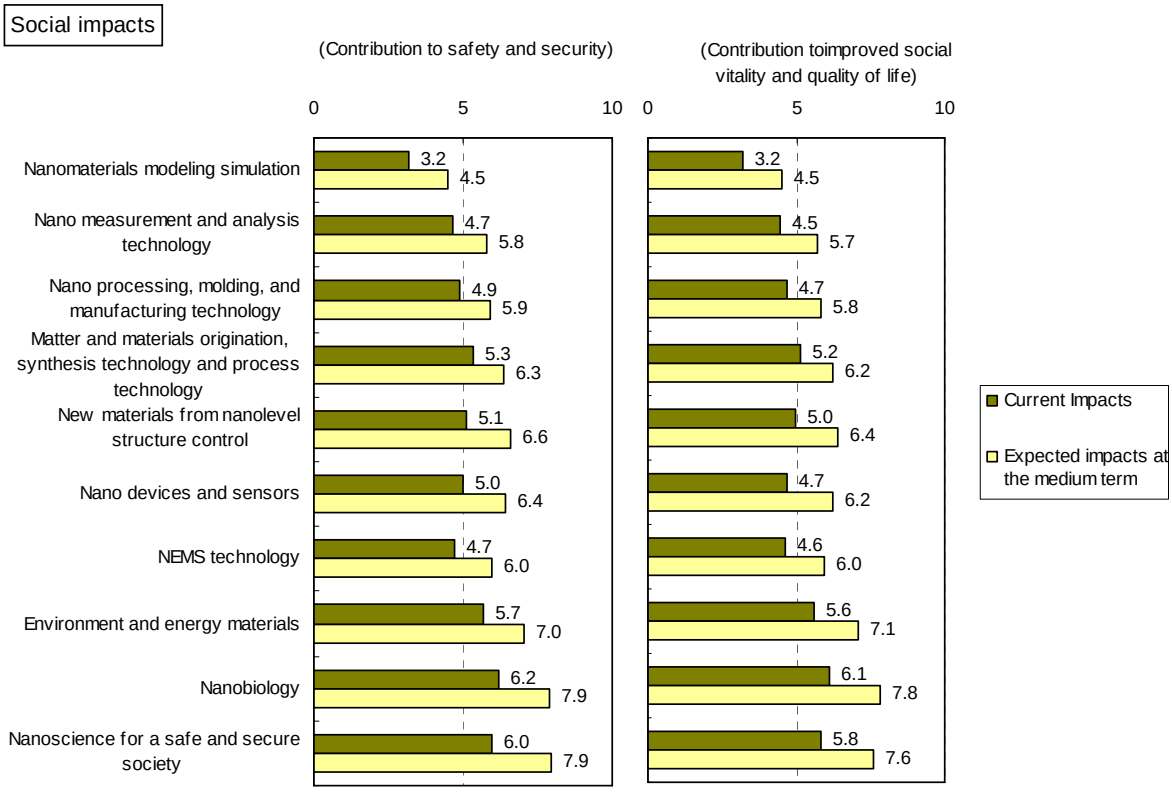
(KAWAI Tomoji)

9.2. Main results

A. Impacts

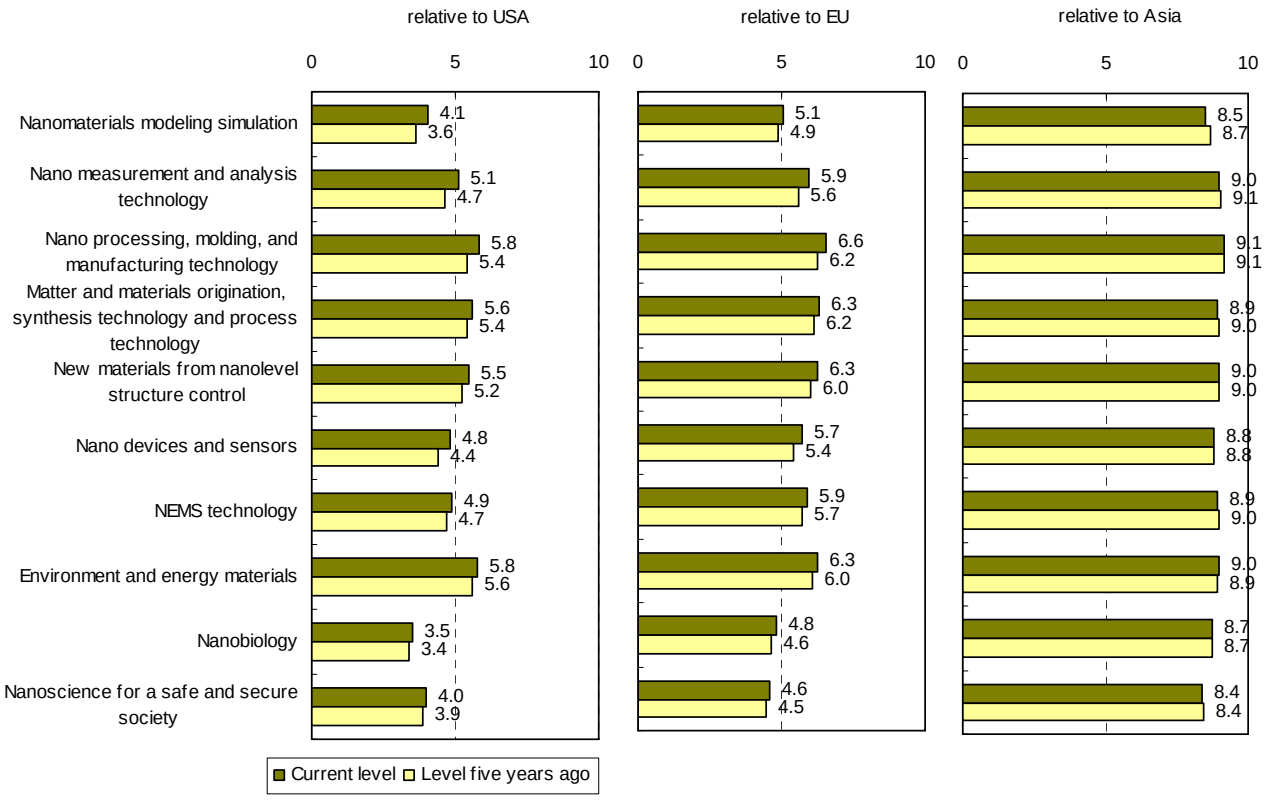


*Responses are indexed on a 10-point scale.



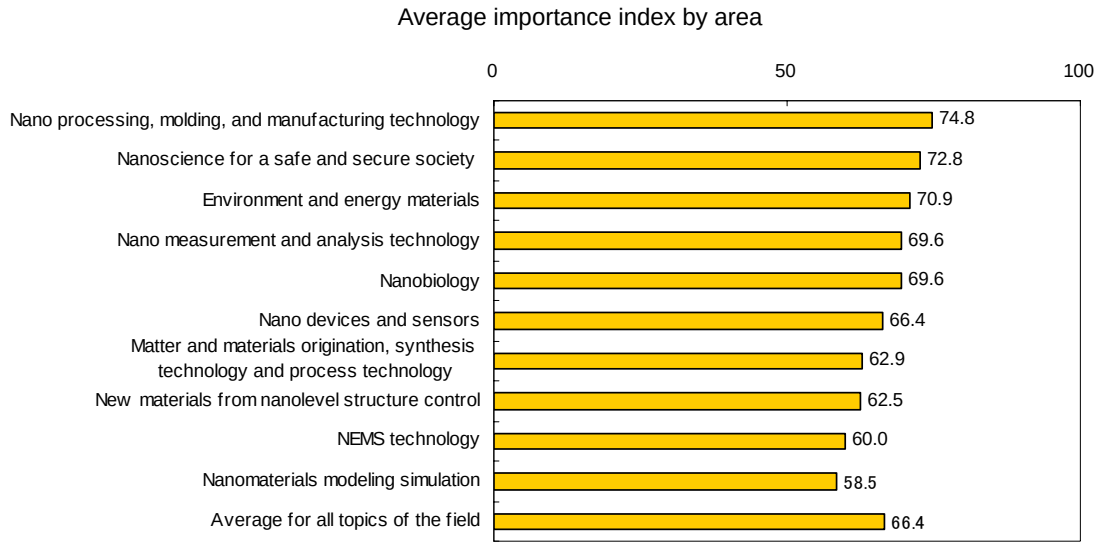
*Responses are indexed on a 10-point scale.

B. Japan's R&D Level



*Responses are indexed on a 10-point scale.

C. Importance to Japan



The most important 10 topics

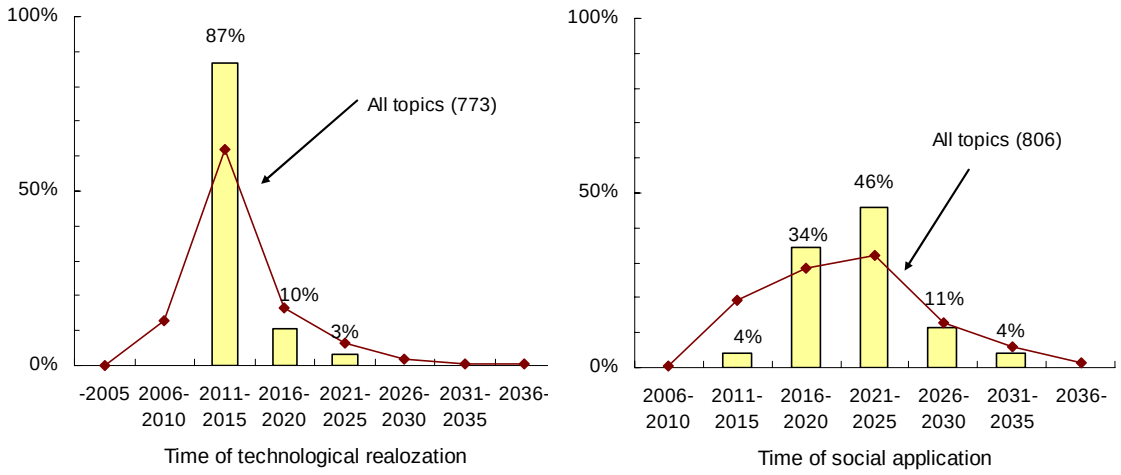
	Topic	Index	Year T*	Year S*
1	14: Production processing technology capable of controlling dimensions and shapes with single nanometer precision.	90	2013	2019
2	38: Large-area amorphous silicon solar cells with a conversion efficiency above 20 percent.	88	2012	2020
3	55: Hydrogen production processes through photocatalytic decomposition of water with sunlight	88	2013	2022
4	65: Biochip diagnostic systems that can accurately diagnose onset risk for cancer and other serious diseases and supply information for setting treatment within a very short time.	87	2012	2020
5	13: Three-dimensional packing technology at the nanometer scale.	84	2013	2020
6	62: Nanocarrier systems that deliver drugs and genes to target cells in the body and are directed by outside signals.	83	2013	2022
7	35: Superconductors with transfer points at room temperature and above.	83	2022	2033
8	16: Manufacture of materials with specified nanoscale structure and characteristics through self-organization.	82	2013	2021
9	08: Scanning probe analysis methods that enable fixed composition analysis and quantitative property measurement at the nanometer scale.	82	2012	2019
10	20: Macromolecule synthesis processes that use renewable resources in place of conventional petrochemical processing.	82	2013	2020

Year T: Time of technological realization Year S: Time of social application

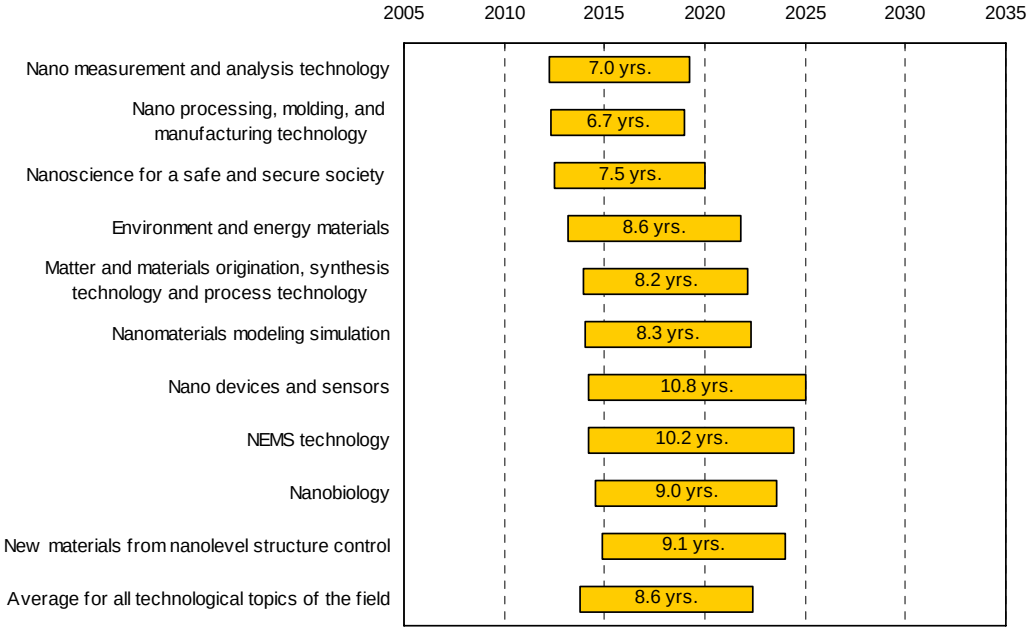
*Responses were indexed on a 100-point scale.

D. Time of realization

Distribution of topics



Gap between technological realization and social application



Topics with short or long periods until social application

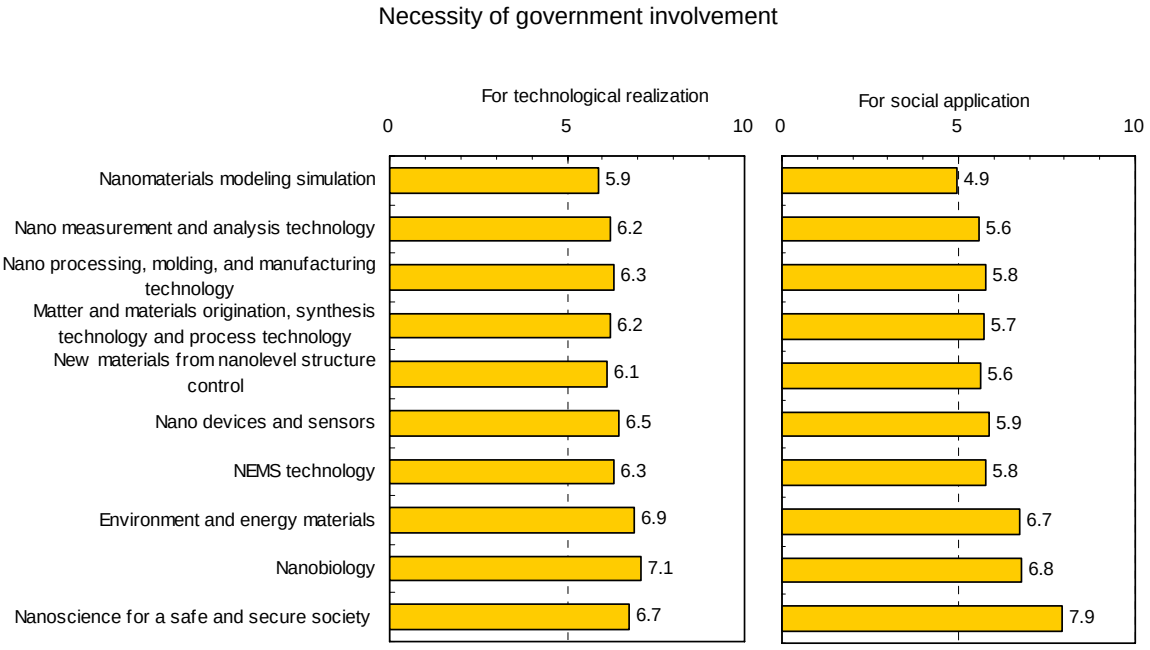
Topic	Year T*	Period*	Area
33: Macromolecule superconducting materials with transfer points above liquid nitrogen temperature.	2019	12	New materials from nanolevel structure control
44: Devices that utilize the switching functions of single molecules and atoms.	2017	12	Nano devices and sensors
45: Molecular devices and sensors that use protein or DNA as elements.	2014	12	Nano devices and sensors
49: NEMS that uses Brownian motion as its motive energy.	2015	12	NEMS technology
26: Artificial photosynthesis technology utilizing dendrimers.	2017	11	Matter and materials origination, synthesis technology and process technology
28: Technology to freely apply organic, inorganic, and metal materials at the nano level.	2015	11	Matter and materials origination, synthesis technology and process technology

Topic	Year T*	Period*	Area
35: Superconductors with transfer points at room temperature and above.	2022	11	New materials from nanolevel structure control
43: Single-electron memory devices	2014	11	Nano devices and sensors
48: Technology that measures/controls spin polarization at the atomic and molecular levels.	2014	11	Nano devices and sensors
50: Nanosurgery manipulators (manipulators that directly manipulate, excise, join, and process biomolecules) for biomolecules.	2014	11	NEMS technology
64: Biocomputer devices utilizing cultured nerve cell networks.	2022	11	Nanobiology

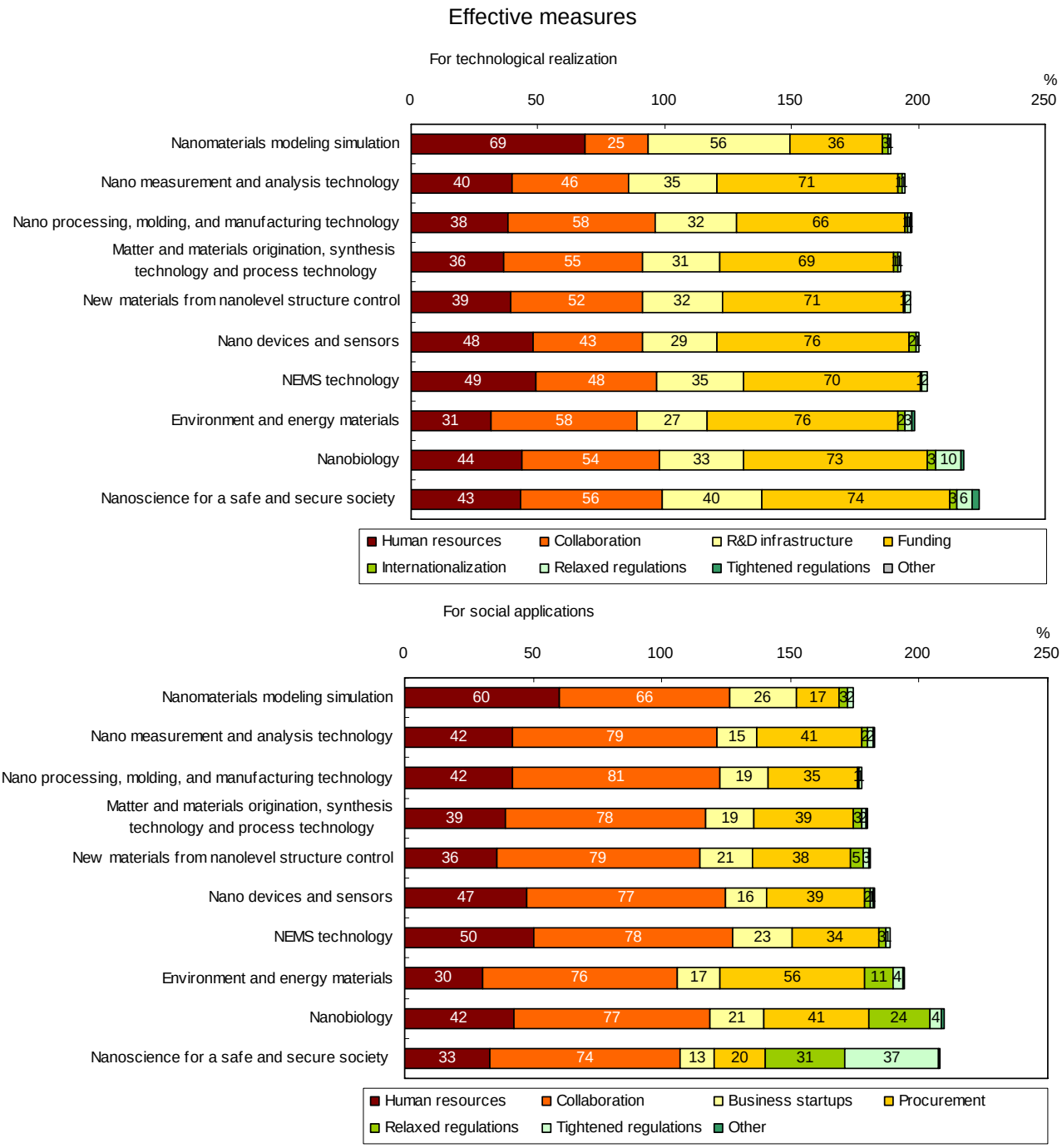
Topic	Year T*	Period*	Area
12: Welding technology that does not degrade the performance of structural materials with outstanding strength, toughness, and fatigue characteristics.	2011	5	Nano processing, molding, and manufacturing technology
19: Organic macromolecules with luminous surfaces for lighting.	2011	5	Matter and materials origination, synthesis technology and process technology
05: Ultrahigh-resolution electron microscope (resolution of 0.05 nm) with aberration correction.	2012	6	Nano measurement and analysis technology
06: Technology to continuously observe and analyze individual atoms and molecules.	2012	6	Nano measurement and analysis technology
14: Production processing technology capable of controlling dimensions and shapes with single nanometer precision.	2013	6	Nano processing, molding, and manufacturing technology

*Year T: Time of technological realization Period: Period until social application (years)

E. Effective measures that should taken by government



*Responses were indexed on a 10-point scale



F. Time-line of topics

Technological realization

year	topic
2011	12: Welding technology that does not degrade the performance of structural materials with outstanding strength, toughness, and fatigue characteristics.
	19: Organic macromolecules with luminous surfaces for lighting.
2012	04: Technology for nondestructive inspection of fatigue in metal materials for in situ prediction of remaining life in light of usage conditions.
	05: Ultrahigh-resolution electron microscope (resolution of 0.05 nm) with aberration correction.
	06: Technology to continuously observe and analyze individual atoms and molecules.
	07: In situ observation technology for high-temperature reactions (near 1500° C).
	08: Scanning probe analysis methods that enable fixed composition analysis and quantitative property measurement at the nanometer scale.

year	topic
	10: Three-dimensional microscope techniques for cells and other soft samples (materials).
	15: Joining technology for ceramic and metal that can withstand thermal fatigue from repeated temperature changes of 500° C or more.
	17: Cheap and convenient nanometer-scale die-forming technology.
	24: Technology that uses gas phase coating to manufacture tools harder than diamond.
	29: Biomedical ceramics that function approximately the same as human bone.
	38: Large-area amorphous silicon solar cells with a conversion efficiency above 20 percent.
	42: Light and composite structure materials from carbon nanotubes.
	65: Biochip diagnostic systems that can accurately diagnose onset risk for cancer and other serious diseases and supply information for setting treatment within a very short time.
	69: Advanced authentication technology utilizing DNA tags.
2013	01: Technology to use simulation based on first-principle analysis to design nanomaterials with fixed (excellent) characteristics.
	09: Chip-type scanning probe analysis equipment.
	11: Three-dimensional fault imaging devices with a resolution on a several nanometer scale.
	13: Three-dimensional packing technology at the nanometer scale.
	14: Production processing technology capable of controlling dimensions and shapes with single nanometer precision.
	16: Manufacture of materials with specified nanoscale structure and characteristics through self-organization.
	20: Macromolecule synthesis processes that use renewable resources in place of conventional petrochemical processing.
	22: Manufacturing technology using nano structure control for ultra-plastic ceramics.
	23: Manufacturing technology for nanochips structured according to design.
	32: Lead-free ferroelectrics with a piezoelectric modulus equivalent to PZT (Pb [Zr, Ti] O3).
	37: Insulating materials with a dielectric constant of 1.3 or less for ultra-LSI.
	39: Organic and inorganic compound materials that express new functions or innovative properties through structures controlled at the nanometer level.
	46: Ultrahigh-speed optical switching devices with an order of femtosecond switching time.
	47: Devices and sensors manufactured with nanometer precision.
	54: Direct catalytic production of hydrogen from methane at low temperature
	55: Hydrogen production processes through photocatalytic decomposition of water with sunlight
	56: Production of iron by a new economical method with hydrogen as reductant instead of coke.
	58: Complete control of nanopores in separation membranes.
	59: Technology to predict three-dimensional structure from the primary sequence structure of proteins with about 30,000 molecules.
	62: Nanocarrier systems that deliver drugs and genes to target cells in the body and are directed by outside signals.
	63: Cell tissue sensors (biosensors composed of cells and tissue) used in place of animal experimentation.
	70: Virus detection technology utilizing protein chips with activity equivalent to that of life forms.
2014	03: Design of nano industrial materials utilizing mutilscale simulation through grid computing.
	18: Methods for protein synthesis with optional structures through in-vitro sequence control that does not use mRNA or tRNA.
	25: Technology to freely control the structure and characteristics of surfaces and interfaces at the atomic level.
	27: Precise polymerization processes that can voluntarily control at the molecular level stereoregularity, linkage structure, and molecule volume and distribution.
	34: Heat resistant alloys that can bear a load of 15 kgf/mm2 (about 150 MPa) for 1,000 hours at a high (atmospheric) temperature of 1200° C.
	40: Nanomaterials that show practical, meaningful stimulus response at necessary times and places.
	41: Semiconductor diamonds at a practical level.
	43: Single-electron memory devices
	45: Molecular devices and sensors that use protein or DNA as elements.
	48: Technology that measures/controls spin polarization at the atomic and molecular levels.

year	topic
	50: Nanosurgery manipulators (manipulators that directly manipulate, excise, join, and process biomolecules) for biomolecules.
	51: Mechanical switching elements that operate at 10 GHz and above and have outstanding ON/OFF characteristics.
	52: Multi-nanoprobe spectroscopic analysis, processing control, and operating technology that enables multi-sensing and multi-processing at the nanometer level of the functional structure of biomolecules such as nano semiconductor devices, molecular devices, nanomaterials, and DNA protein.
	53: Probe array-type sensor elements sensitive enough to detect single molecules.
	57: Catalytic fixation of carbon dioxide that will solve one of the global environmental problems.
	60: Actuators made from intelligent materials that can be utilized in medical devices for the in vivo use such as microsurgery.
2015	02: For dimensional materials, computer simulation technology and nonequilibrium nanomaterials databases that can strictly predict structure and properties in thermal equilibrium state when given elemental composition.
	28: Technology to freely apply organic, inorganic, and metal materials at the nano level.
	49: NEMS that uses Brownian motion as its motive energy.
	61: Hybrid-type artificial organs with self-organized tissue derived from stem cells.
2016	31: Macromolecule materials with conductivity and environment resistance equivalent to copper at room temperature.
	36: Anisotropic nanocomposite magnets with a (BH)max=400 kJ/m3(50.3 MGOe) or greater through nanometer-scale control of heterostructure.
2017	21: Technology to directly synthesize plastic form carbon dioxide gas and water, using light as an energy source.
	26: Artificial photosynthesis technology utilizing dendrimers.
	44: Devices that utilize the switching functions of single molecules and atoms.
2018	30: All-organic ferromagnets with a Curie point above room temperature.
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2022	35: Superconductors with transfer points at room temperature and above.
	64: Biocomputer devices utilizing cultured nerve cell networks.

Social application

year	topic
2012	67: Establishment of safety standards for nanoparticles in consumer goods such as cosmetics and foods.
2013	66: Establishment of safety standards for DDS capsule materials and doses.
	68: Establishment of manufacturing standards for diagnostic DNA and protein chips.
2016	12: Welding technology that does not degrade the performance of structural materials with outstanding strength, toughness, and fatigue characteristics.
	19: Organic macromolecules with luminous surfaces for lighting.
2018	05: Ultrahigh-resolution electron microscope (resolution of 0.05 nm) with aberration correction.
	06: Technology to continuously observe and analyze individual atoms and molecules.
2019	04: Technology for nondestructive inspection of fatigue in metal materials for in situ prediction of remaining life in light of usage conditions.
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	24: Technology that uses gas phase coating to manufacture tools harder than diamond.
2020	09: Chip-type scanning probe analysis equipment.
	10: Three-dimensional microscope techniques for cells and other soft samples (materials).
	13: Three-dimensional packing technology at the nanometer scale.

year	topic
	20: Macromolecule synthesis processes that use renewable resources in place of conventional petrochemical processing.
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	29: Biomedical ceramics that function approximately the same as human bone.
	37: Insulating materials with a dielectric constant of 1.3 or less for ultra-LSI.
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	42: Light and composite structure materials from carbon nanotubes.
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	60: Actuators made from intelligent materials that can be utilized in medical devices for the in vivo use such as microsurgery.
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2024	02: For dimensional materials, computer simulation technology and nonequilibrium nanomaterials databases that can strictly predict structure and properties in thermal equilibrium state when given elemental composition.
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	61: Hybrid-type artificial organs with self-organized tissue derived from stem cells.
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year	topic
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	48: Technology that measures/controls spin polarization at the atomic and molecular levels.
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2026	21: Technology to directly synthesize plastic form carbon dioxide gas and water, using light as an energy source.
	28: Technology to freely apply organic, inorganic, and metal materials at the nano level.
	31: Macromolecule materials with conductivity and environment resistance equivalent to copper at room temperature.
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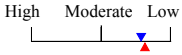
2033	35: Superconductors with transfer points at room temperature and above.
	64: Biocomputer devices utilizing cultured nerve cell networks.

Appendix: Results of R1 and R2

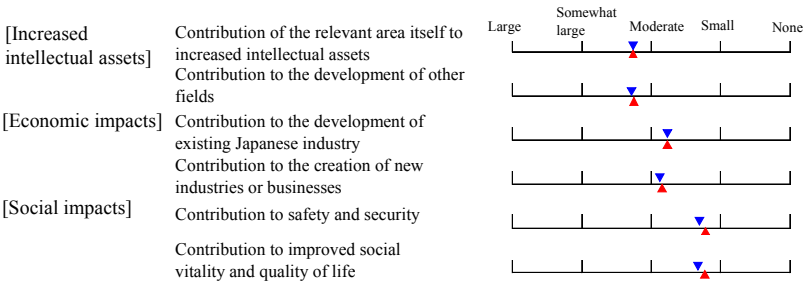
I. Nanomaterials modeling simulation

1. Questions regarding the relevant area

1) Degree of expertise in the area

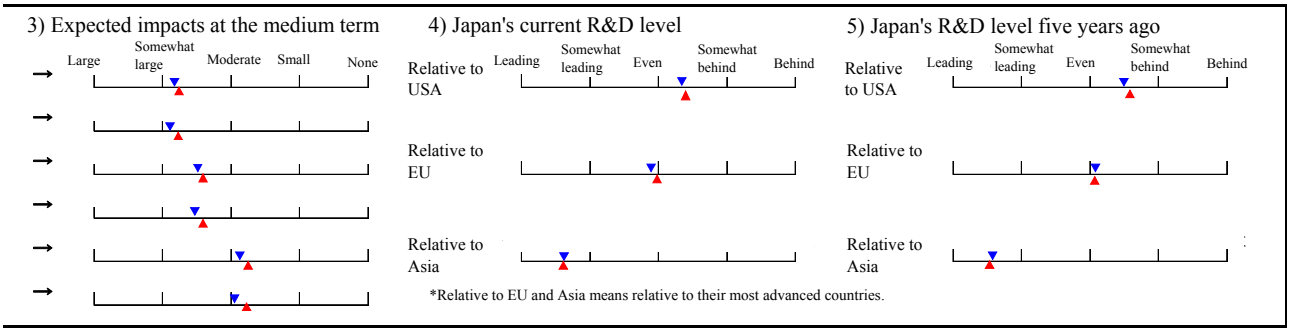


2) Current impacts



2. Questions regarding topics

No	Topic	Questionnaire	Respondents (persons)	Degree of expertise (%)				Importance to Japan					Time of technological realization									
				High	Moderate	Low	None	Index	High	Moderate	Low	None	Already realized	2006–2010	2011–2015	2016–2025	2026–2035	2036–	Will not be realized	Do not know		
																				(%)		
1	Technology to use simulation based on first-principle analysis to design nanomaterials with fixed (excellent) characteristics.	1	**142**	**8**	**27**	**65**	**-**	**68**	**42**	**47**	**11**	**0**							**4**	**8**
		2	**120**	**5**	**28**	**67**	**-**	**60**	**24**	**68**	**8**	**0**							**2**	**4**
		E	**6**	**100**	**0**	**0**	**-**	**92**	**83**	**17**	**0**	**0**							**0**	**0**
2	For dimensional materials, computer simulation technology and nonequilibrium nanomaterials databases that can strictly predict structure and properties in thermal equilibrium state when given elemental composition.	1	**125**	**7**	**17**	**76**	**-**	**66**	**38**	**51**	**11**	**0**							**3**	**16**
		2	**114**	**5**	**18**	**77**	**-**	**59**	**22**	**69**	**9**	**0**							**1**	**6**
		E	**6**	**100**	**0**	**0**	**-**	**92**	**83**	**17**	**0**	**0**							**0**	**0**
3	Design of nano industrial materials utilizing mutilscale simulation through grid computing.	1	**102**	**8**	**17**	**75**	**-**	**66**	**39**	**47**	**14**	**0**							**4**	**8**
		2	**101**	**4**	**8**	**88**	**-**	**57**	**18**	**73**	**9**	**0**							**1**	**6**
		E	**4**	**100**	**0**	**0**	**-**	**88**	**75**	**25**	**0**	**0**							**0**	**0**



*Relative to EU and Asia means relative to their most advanced countries.

Countries at the leading edge					Regarding technological realization												Time of social application							Regarding social application											
					Necessity of gov't involvement				Effective measures that should be taken by gov't															Necessity of gov't involvement				Effective measures that should be taken by gov't						
Japan	USA	EU	Asia	Other	High	Moderate	Low	None	Human resources development	Strengthened industry-academic-government and interdisciplinary collaboration	Development of R&D infrastructure	Expansion of R&D funding	Internationalization of R&D activities	Relaxation or elimination of relevant regulations	Tightened or new regulations	Other	2006–2010	2011–2015	2016–2025	2026–2035	2036–	Will not be applied	Do not know	High	Moderate	Low	None	Human resources development	Strengthened industry-academic-government and interdisciplinary collaboration	Improvement of environment for business startups	Support through taxation, subsidies, and procurement	Relaxation or elimination of relevant regulations	Tightened or new regulations	Other
(%)					(%)				(%)													(%)		(%)				(%)						
14	78	8	0	0	30	37	25	8	53	32	46	35	9	2	0	0						4	10	20	29	34	17	51	54	28	24	9	2	1
2	96	2	0	0	14	52	29	5	70	21	54	38	3	1	0	0						2	4	6	36	50	8	62	63	26	17	3	2	0
0	100	0	0	0	33	67	0	0	67	17	67	67	0	0	0	0						0	0	17	83	0	0	83	50	33	33	0	0	0
12	74	13	0	1	27	45	19	9	53	40	47	38	7	1	0	0						4	16	19	36	27	18	47	60	31	22	7	1	2
0	94	5	0	1	12	55	28	5	69	27	58	33	3	1	0	0						1	7	6	46	38	10	56	70	26	17	3	2	0
0	83	17	0	0	17	66	17	0	67	33	50	33	0	0	0	0						0	0	17	66	17	0	67	67	17	33	0	0	0
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2	95	2	0	1	12	62	21	5	67	26	57	38	2	1	0	0						1	7	5	53	35	7	62	66	26	16	3	2	0
0	100	0	0	0	50	50	0	0	50	50	25	75	0	0	0	0						0	0	25	75	0	0	50	25	25	75	0	0	0

II. Nano measurement and analysis technology

1. Questions regarding the relevant area

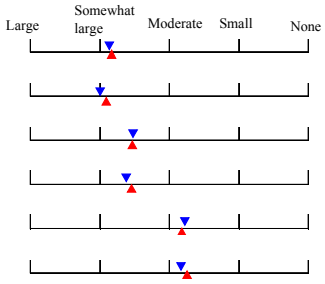
1) Degree of expertise in the area

2) Current impacts

[Increased intellectual assets]
- Contribution of the relevant area itself to increased intellectual assets
- Contribution to the development of other fields

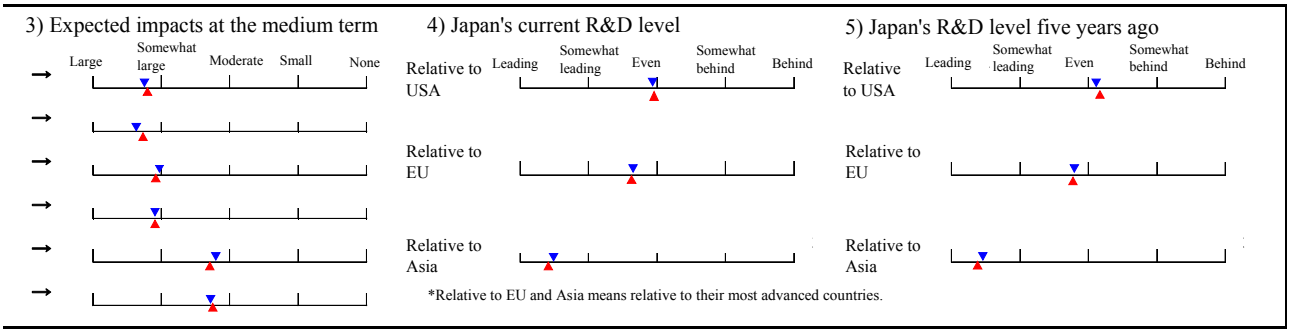
[Economic impacts]
- Contribution to the development of existing Japanese industry
- Contribution to the creation of new industries or businesses

[Social impacts]
- Contribution to safety and security
- Contribution to improved social vitality and quality of life



2. Questions regarding topics

No	Topic	Questionnaire	Respondents (persons)	Degree of expertise (%)				Importance to Japan					Time of technological realization								
				High	Moderate	Low	None	Index	High	Moderate	Low	None	Already realized	2006–2010	2011–2015	2016–2025	2026–2035	2036–	Will not be realized	Do not know
																			(%)	
4	Technology for nondestructive inspection of fatigue in metal materials for in situ prediction of remaining life in light of usage conditions.	1	105	4	29	67	-	68	39	53	8	0							1	9
		2	100	3	18	79	-	61	24	71	5	0							1	2
		E	3	100	0	0	-	83	67	33	0	0							0	0
5	Ultrahigh-resolution electron microscope (resolution of 0.05 nm) with aberration correction.	1	140	8	32	60	-	68	44	43	12	1							1	10
		2	127	6	24	70	-	64	32	60	8	0							0	4
		E	7	100	0	0	-	82	72	14	14	0							0	0
6	Technology to continuously observe and analyze individual atoms and molecules.	1	172	24	31	45	-	77	57	39	4	0							1	3
		2	142	18	28	54	-	80	62	36	2	0							0	1
		E	26	100	0	0	-	94	88	12	0	0							0	0
7	In situ observation technology for high-temperature reactions (near 1500°C).	1	112	13	25	62	-	57	28	43	28	1							1	7
		2	105	6	15	79	-	52	14	67	18	1							0	4
		E	6	100	0	0	-	63	33	50	17	0							0	0
8	Scanning probe analysis methods that enable fixed composition analysis and quantitative property measurement at the nanometer scale.	1	165	26	33	41	-	76	55	37	8	0							1	5
		2	133	23	27	50	-	82	66	32	2	0							0	2
		E	30	100	0	0	-	94	90	7	3	0							0	0
9	Chip-type scanning probe analysis equipment.	1	136	19	36	45	-	67	42	44	14	0							0	3
		2	124	13	23	64	-	64	33	57	10	0							0	2
		E	16	100	0	0	-	86	81	0	19	0							0	0
10	Three-dimensional microscope techniques for cells and other soft samples (materials).	1	123	13	31	56	-	78	59	37	3	1							0	4
		2	114	8	20	72	-	81	62	34	4	0							0	4
		E	9	100	0	0	-	94	89	11	0	0							0	0
11	Three-dimensional fault imaging devices with a resolution on a several nanometer scale.	1	122	7	32	61	-	73	49	44	7	0							0	4
		2	112	5	18	77	-	73	50	45	5	0							0	1
		E	6	100	0	0	-	92	83	17	0	0							0	0

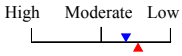


Countries at the leading edge					Regarding technological realization													Time of social application							Regarding social application											
					Necessity of gov't involvement				Effective measures that should be taken by gov't																Necessity of gov't involvement				Effective measures that should be taken by gov't							
Japan	USA	EU	Asia	Other	High	Moderate	Low	None	Human resources development	Strengthened industry-academic-government and interdisciplinary collaboration	Development of R&D infrastructure	Expansion of R&D funding	Internationalization of R&D activities	Relaxation or elimination of relevant regulations	Tightened or new regulations	Other	2006–2010	2011–2015	2016–2025	2026–2035	2036–	Will not be applied	Do not know	High	Moderate	Low	None	Human resources development	Strengthened industry-academic-government and interdisciplinary collaboration	Improvement of environment for business startups	Support through taxation, subsidies, and procurement	Relaxation or elimination of relevant regulations	Tightened or new regulations	Other
(%)					(%)				(%)													(%)		(%)				(%)							
43	52	5	0	0	21	50	22	7	31	46	32	50	4	2	2	1						1	9	20	46	24	10	35	60	22	29	4	8	0
46	53	0	0	1	12	74	12	2	35	63	32	58	1	2	0	0						1	1	5	71	18	6	42	84	13	26	4	5	1
100	0	0	0	0	33	67	0	0	33	100	67	33	0	0	0	0						0	0	0	67	33	0	33	100	0	33	33	0	0
65	27	6	0	2	17	45	26	12	28	30	36	63	8	2	0	1						3	10	11	39	33	17	39	51	18	49	4	0	0
87	12	1	0	0	7	64	25	4	27	36	37	74	0	1	0	0						0	2	2	56	36	6	32	80	10	47	3	2	1
86	14	0	0	0	28	29	14	29	40	80	20	60	0	20	0	0						0	0	0	71	0	29	60	80	20	40	0	20	0
31	59	9	0	1	27	41	21	11	42	30	40	63	8	1	0	1						3	6	14	39	31	16	44	58	22	36	5	0	0
19	80	1	0	0	12	64	21	3	45	38	40	75	1	1	0	0						0	1	4	59	32	5	48	79	16	40	2	2	1
40	56	4	0	0	19	54	19	8	67	46	67	75	4	4	0	0						0	0	8	68	12	12	65	74	26	43	4	4	0
35	53	8	0	4	11	47	33	9	29	33	35	53	9	1	0	2						1	12	8	34	43	15	36	53	18	40	5	1	1
17	78	0	2	3	7	62	28	3	36	41	33	70	2	2	0	0						0	3	4	42	49	5	38	76	11	46	2	2	1
20	80	0	0	0	17	49	17	17	60	60	20	100	0	0	0	0						0	0	17	49	17	17	60	100	20	40	0	0	0
30	57	12	0	1	26	44	23	7	44	34	37	65	10	1	0	0						1	6	14	43	31	12	46	56	20	40	3	1	0
16	82	2	0	0	10	71	17	2	46	42	33	73	2	1	0	0						0	1	3	69	21	7	44	76	16	45	2	2	1
28	65	7	0	0	33	51	13	3	59	55	52	72	3	3	0	0						0	0	10	73	7	10	58	81	38	46	4	4	0
26	59	14	0	1	21	46	25	8	32	40	36	57	5	1	0	1						1	4	13	44	32	11	42	57	27	35	4	0	1
12	82	5	1	0	8	77	13	2	34	53	34	72	1	1	0	0						0	0	2	68	24	6	37	79	18	42	2	2	1
7	73	20	0	0	31	50	13	6	27	47	53	73	0	7	0	0						0	0	7	79	7	7	36	79	43	43	0	7	0
31	61	7	0	1	33	41	18	8	46	44	43	64	12	1	0	1						1	6	21	46	24	9	54	59	23	41	5	1	0
15	84	1	0	0	15	69	11	5	53	49	35	73	4	1	0	0						0	1	8	71	17	4	52	81	21	35	1	2	1
44	56	0	0	0	22	56	11	11	63	38	38	88	0	13	0	0						0	0	33	67	0	0	44	33	56	44	0	11	0
31	57	10	0	2	30	47	20	3	41	43	41	60	9	3	1	2						0	7	25	40	26	9	47	58	26	50	6	0	0
12	87	1	0	0	10	75	11	4	43	46	38	75	1	1	0	0						0	1	4	74	18	4	44	80	19	44	2	2	1
33	67	0	0	0	33	33	17	17	60	40	40	80	0	20	0	0						0	0	50	50	0	0	33	33	67	33	0	17	0

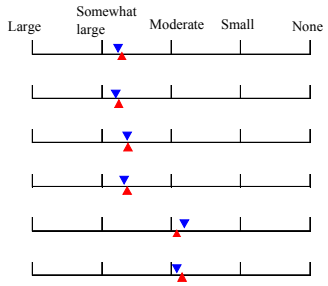
III. Nano processing, molding, and manufacturing technology

1. Questions regarding the relevant area

1) Degree of expertise in the area

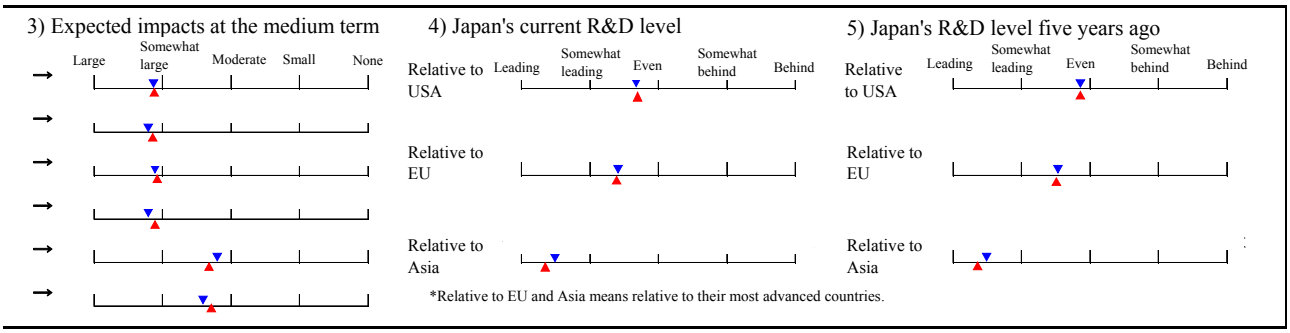


2) Current impacts



2. Questions regarding topics

No	Topic	Questionnaire	Respondents (persons)	Degree of expertise (%)				Importance to Japan					Time of technological realization									
				High	Moderate	Low	None	Index	High	Moderate	Low	None	Already realized	2006–2010	2011–2015	2016–2025	2026–2035	2036–	Will not be realized	Do not know
12	Welding technology that does not degrade the performance of structural materials with outstanding strength, toughness, and fatigue characteristics.	1	**70**	**9**	**27**	**64**	-	**64**	**34**	**55**	**10**	**1**							**2**	**9**
		2	**82**	**1**	**17**	**82**	-	**55**	**15**	**75**	**9**	**1**							**0**	**3**
		E	**1**	**100**	**0**	**0**	-	**100**	**100**	**0**	**0**	**0**							**0**	**0**
13	Three-dimensional packing technology at the nanometer scale.	1	**128**	**16**	**38**	**46**	-	**78**	**58**	**38**	**4**	**0**							**0**	**3**
		2	**113**	**8**	**39**	**53**	-	**84**	**69**	**30**	**1**	**0**							**0**	**1**
		E	**9**	**100**	**0**	**0**	-	**94**	**89**	**11**	**0**	**0**							**0**	**0**
14	Production processing technology capable of controlling dimensions and shapes with single nanometer precision.	1	**111**	**14**	**36**	**50**	-	**80**	**62**	**31**	**7**	**0**							**1**	**3**
		2	**104**	**7**	**26**	**67**	-	**90**	**81**	**18**	**1**	**0**							**0**	**1**
		E	**7**	**100**	**0**	**0**	-	**100**	**100**	**0**	**0**	**0**							**0**	**0**
15	Joining technology for ceramic and metal that can withstand thermal fatigue from repeated temperature changes of 500°C or more.	1	**80**	**8**	**25**	**67**	-	**63**	**33**	**54**	**12**	**1**							**0**	**12**
		2	**85**	**4**	**15**	**81**	-	**56**	**16**	**78**	**5**	**1**							**0**	**4**
		E	**3**	**100**	**0**	**0**	-	**100**	**100**	**0**	**0**	**0**							**0**	**0**
16	Manufacture of materials with specified nanoscale structure and characteristics through self-organization.	1	**163**	**23**	**33**	**44**	-	**75**	**55**	**37**	**8**	**0**							**1**	**3**
		2	**143**	**17**	**32**	**51**	-	**82**	**66**	**32**	**2**	**0**							**0**	**1**
		E	**24**	**100**	**0**	**0**	-	**96**	**92**	**8**	**0**	**0**							**0**	**0**
17	Cheap and convenient nanometer-scale die-forming technology.	1	**119**	**18**	**32**	**50**	-	**73**	**51**	**39**	**9**	**1**							**1**	**3**
		2	**105**	**13**	**26**	**61**	-	**81**	**64**	**32**	**4**	**0**							**0**	**2**
		E	**14**	**100**	**0**	**0**	-	**93**	**86**	**14**	**0**	**0**							**0**	**0**



Countries at the leading edge					Regarding technological realization												Time of social application							Regarding social application													
					Necessity of gov't involvement				Effective measures that should be taken by gov't															Necessity of gov't involvement				Effective measures that should be taken by gov't									
Japan	USA	EU	Asia	Other	High	Moderate	Low	None	Human resources development	Strengthened industry-academic-government and interdisciplinary collaboration	Development of R&D infrastructure	Expansion of R&D funding	Internationalization of R&D activities	Relaxation or elimination of relevant regulations	Tightened or new regulations	Other	2006–2010	2011–2015	2016–2025	2026–2035	2036–	Will not be applied	Do not know	High	Moderate	Low	None	Human resources development	Strengthened industry-academic-government and interdisciplinary collaboration	Improvement of environment for business startups	Support through taxation, subsidies, and procurement	Relaxation or elimination of relevant regulations	Tightened or new regulations	Other
(%)					(%)				(%)													(%)		(%)				(%)							
64	29	5	0	2	8	54	29	9	41	49	32	46	5	2	0	2						2	11	11	41	35	13	40	53	25	36	7	2	0
89	11	0	0	0	2	70	19	9	39	70	22	51	3	1	0	0						0	4	5	56	30	9	40	77	15	32	1	1	0
100	0	0	0	0	100	0	0	0	0	0	0	100	0	0	0	0						0	0	100	0	0	0	0	100	0	0	0	0	0
42	53	5	0	0	30	46	21	3	42	45	43	60	11	2	1	0						0	4	26	44	24	6	41	68	34	39	5	1	0
38	61	1	0	0	17	68	14	1	46	46	38	73	0	2	0	0						0	2	9	66	20	5	47	82	18	33	0	1	0
33	67	0	0	0	22	78	0	0	44	33	44	67	0	0	0	0						0	0	22	56	22	0	56	89	11	22	0	0	0
62	32	5	1	0	32	46	18	4	44	49	46	59	8	2	1	0						2	4	30	39	25	6	47	65	35	39	6	1	0
88	11	1	0	0	10	71	17	2	35	57	33	72	0	1	0	1						0	2	8	65	21	6	42	82	22	38	0	1	0
100	0	0	0	0	29	71	0	0	29	43	29	71	0	0	0	0						0	0	29	57	14	0	29	86	14	29	0	0	0
51	46	3	0	0	20	47	27	6	39	45	39	42	3	1	0	1						0	15	17	37	38	8	43	55	20	35	5	0	0
67	33	0	0	0	7	69	19	5	33	65	30	65	1	1	0	0						0	4	10	46	37	7	35	83	14	34	1	1	0
33	67	0	0	0	100	0	0	0	33	33	67	100	0	0	0	0						0	0	100	0	0	0	33	100	0	33	0	0	0
39	53	7	0	1	31	41	21	7	44	49	40	65	6	1	0	0						2	6	21	45	23	11	48	63	34	39	5	0	0
26	73	1	0	0	21	65	11	3	42	55	34	71	1	1	0	0						0	1	11	68	15	6	48	81	22	34	1	1	0
39	61	0	0	0	38	58	4	0	42	46	33	75	0	4	0	0						0	0	29	58	13	0	48	74	13	43	0	0	0
51	44	5	0	0	27	47	20	6	42	47	43	57	6	1	0	0						2	5	23	44	22	11	44	57	38	42	4	1	0
72	28	0	0	0	15	65	19	1	36	54	35	66	2	1	0	0						0	3	11	65	19	5	39	79	23	38	0	1	0
71	29	0	0	0	29	71	0	0	21	50	36	71	0	0	0	0						0	0	36	64	0	0	21	86	21	36	0	0	0

IV. Matter and materials origination, synthesis technology and process technology

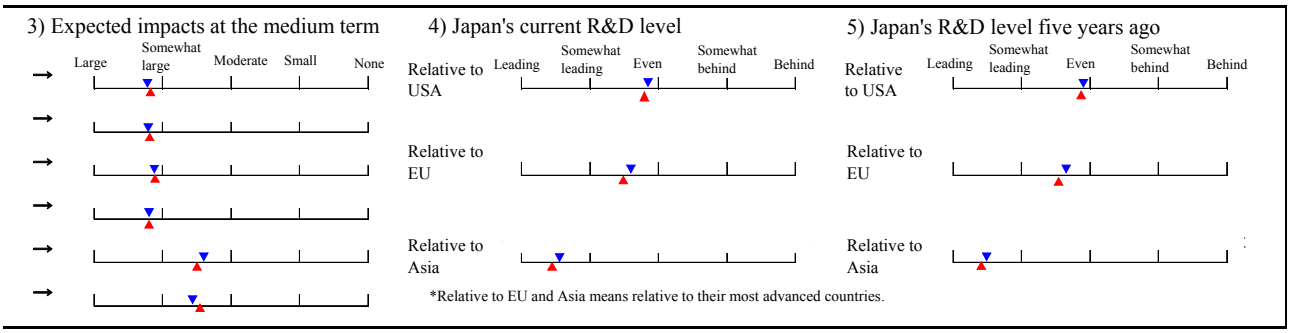
1. Questions regarding the relevant area

1) Degree of expertise in the area

2) Current impacts

2. Questions regarding topics

No	Topic	Questionnaire	Respondents (persons)	Degree of expertise (%)				Importance to Japan					Time of technological realization								
				High	Moderate	Low	None	Index	High	Moderate	Low	None	Already realized	2006–2010	2011–2015	2016–2025	2026–2035	2036–	Will not be realized (%)	Do not know (%)
18	Methods for protein synthesis with optional structures through in-vitro sequence control that does not use mRNA or tRNA.	1	**78**	**8**	**26**	**66**	-	**66**	**36**	**55**	**9**	**0**							**3**	**5**
		2	**82**	**4**	**15**	**81**	-	**59**	**21**	**74**	**5**	**0**							**0**	**4**
		E	**3**	**100**	**0**	**0**	-	**75**	**67**	**0**	**33**	**0**							**0**	**0**
19	Organic macromolecules with luminous surfaces for lighting.	1	**127**	**12**	**22**	**66**	-	**69**	**42**	**51**	**7**	**0**							**0**	**1**
		2	**110**	**5**	**27**	**68**	-	**65**	**33**	**61**	**5**	**1**							**0**	**1**
		E	**5**	**100**	**0**	**0**	-	**90**	**80**	**20**	**0**	**0**							**0**	**0**
20	Macromolecule synthesis processes that use renewable resources in place of conventional petrochemical processing.	1	**104**	**15**	**32**	**53**	-	**74**	**54**	**37**	**9**	**0**							**2**	**1**
		2	**102**	**11**	**25**	**64**	-	**82**	**66**	**31**	**3**	**0**							**3**	**2**
		E	**11**	**100**	**0**	**0**	-	**80**	**70**	**10**	**20**	**0**							**27**	**0**
21	Technology to directly synthesize plastic form carbon dioxide gas and water, using light as an energy source.	1	**98**	**13**	**27**	**60**	-	**69**	**48**	**35**	**16**	**1**							**5**	**9**
		2	**102**	**7**	**24**	**69**	-	**75**	**54**	**40**	**5**	**1**							**4**	**7**
		E	**7**	**100**	**0**	**0**	-	**61**	**43**	**29**	**14**	**14**							**43**	**0**
22	Manufacturing technology using nano structure control for ultra-plastic ceramics.	1	**96**	**19**	**21**	**60**	-	**61**	**33**	**45**	**22**	**0**							**0**	**9**
		2	**94**	**3**	**16**	**81**	-	**54**	**13**	**77**	**10**	**0**							**1**	**3**
		E	**3**	**100**	**0**	**0**	-	**67**	**33**	**67**	**0**	**0**							**0**	**0**
23	Manufacturing technology for nanochips structured according to design.	1	**139**	**19**	**29**	**52**	-	**63**	**36**	**45**	**18**	**1**							**1**	**3**
		2	**120**	**8**	**25**	**67**	-	**56**	**18**	**71**	**10**	**1**							**0**	**0**
		E	**9**	**100**	**0**	**0**	-	**75**	**56**	**33**	**11**	**0**							**0**	**0**
24	Technology that uses gas phase coating to manufacture tools harder than diamond.	1	**94**	**11**	**29**	**60**	-	**56**	**24**	**54**	**21**	**1**							**6**	**9**
		2	**95**	**2**	**24**	**74**	-	**52**	**12**	**74**	**14**	**0**							**2**	**4**
		E	**2**	**100**	**0**	**0**	-	**38**	**0**	**50**	**50**	**0**							**0**	**0**
25	Technology to freely control the structure and characteristics of surfaces and interfaces at the atomic level.	1	**144**	**22**	**33**	**45**	-	**69**	**42**	**50**	**8**	**0**							**2**	**4**
		2	**129**	**19**	**29**	**52**	-	**65**	**32**	**63**	**5**	**0**							**1**	**2**
		E	**24**	**100**	**0**	**0**	-	**82**	**67**	**29**	**4**	**0**							**0**	**0**



Countries at the leading edge					Regarding technological realization												Time of social application							Regarding social application											
					Necessity of gov't involvement				Effective measures that should be taken by gov't															Necessity of gov't involvement				Effective measures that should be taken by gov't							
Japan	USA	EU	Asia	Other	High	Moderate	Low	None	Human resources development	Strengthened industry-academic-government and interdisciplinary collaboration	Development of R&D infrastructure	Expansion of R&D funding	Internationalization of R&D activities	Relaxation or elimination of relevant regulations	Tightened or new regulations	Other	2006–2010	2011–2015	2016–2025	2026–2035	2036–	Will not be applied	Do not know	High	Moderate	Low	None	Human resources development	Strengthened industry-academic-government and interdisciplinary collaboration	Improvement of environment for business startups	Support through taxation, subsidies, and procurement	Relaxation or elimination of relevant regulations	Tightened or new regulations	Other
(%)					(%)				(%)													(%)		(%)				(%)							
16	80	4	0	0	29	49	19	3	35	39	31	61	13	7	0	0						3	8	15	57	19	9	35	53	30	38	17	3	0
4	96	0	0	0	10	71	15	4	41	49	24	64	5	3	0	0						0	3	5	76	14	5	40	75	19	37	5	1	0
33	67	0	0	0	34	33	0	33	0	0	0	100	0	0	0	0						0	0	34	33	33	0	67	33	33	67	0	0	0
65	30	2	3	0	19	52	19	10	30	57	33	65	6	4	1	0						2	2	11	38	38	13	26	54	39	40	13	4	0
86	11	3	0	0	8	69	15	8	26	70	26	62	0	1	0	0						0	1	6	54	30	10	24	80	28	45	2	1	0
100	0	0	0	0	60	40	0	0	20	100	0	40	0	0	0	0						0	0	20	60	20	0	20	80	40	60	20	0	0
41	46	12	0	1	35	44	15	6	33	56	40	59	7	5	2	1						3	2	29	44	22	5	30	57	36	51	16	11	1
35	60	5	0	0	26	62	10	2	27	64	32	68	3	1	1	0						3	1	17	69	10	4	25	84	18	51	8	3	0
60	30	10	0	0	27	27	37	9	10	40	40	60	20	0	0	0						27	0	28	18	27	27	13	88	25	50	13	0	0
32	47	15	0	6	30	38	20	12	31	44	48	56	9	5	1	0						8	13	21	39	27	13	35	52	33	40	15	9	1
25	69	5	0	1	22	63	13	2	31	44	44	69	2	1	0	0						3	6	17	66	13	4	37	72	17	47	6	1	1
66	17	17	0	0	28	29	29	14	0	17	0	67	17	0	0	0						43	0	28	29	14	29	20	40	0	20	0	0	20
64	28	7	0	1	15	58	20	7	35	47	33	60	4	2	1	1						0	11	12	44	36	8	34	59	28	41	5	1	1
90	10	0	0	0	1	80	18	1	35	62	28	69	0	1	0	0						0	4	2	69	23	6	36	77	21	47	1	2	1
100	0	0	0	0	0	100	0	0	0	33	33	100	0	0	0	0						0	0	0	100	0	0	0	100	0	67	0	0	0
55	45	0	0	0	24	41	27	8	39	58	38	63	5	2	0	0						4	10	18	37	29	16	38	57	37	39	6	2	1
78	22	0	0	0	5	71	21	3	35	67	31	70	1	1	0	0						0	1	3	66	23	8	37	77	23	43	2	2	1
78	22	0	0	0	33	45	11	11	13	63	25	75	0	0	0	0						0	0	11	67	11	11	25	63	25	38	0	0	0
63	28	6	0	3	12	47	30	11	33	45	29	56	4	3	1	1						1	10	9	38	38	15	34	50	35	40	7	3	0
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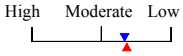
No	Topic	Questionnaire	Respondents (persons)	Degree of expertise (%)				Importance to Japan (%)					Time of technological realization (%)								
				High	Moderate	Low	None	Index	High	Moderate	Low	None	Already realized	2006–2010	2011–2015	2016–2025	2026–2035	2036–	Will not be realized	Do not know
26	Artificial photosynthesis technology utilizing dendrimers.	1	**100**	**14**	**20**	**66**	-	**52**	**25**	**37**	**35**	**3**							**8**	**14**
		2	**97**	**6**	**23**	**71**	-	**47**	**10**	**57**	**32**	**1**							**3**	**7**
		E	**6**	**100**	**0**	**0**	-	**50**	**17**	**66**	**0**	**17**							**33**	**0**
27	Precise polymerization processes that can voluntarily control at the molecular level stereoregularity, linkage structure, and molecule volume and distribution.	1	**107**	**18**	**24**	**58**	-	**64**	**37**	**46**	**16**	**1**							**4**	**5**
		2	**107**	**7**	**18**	**75**	-	**57**	**18**	**75**	**7**	**0**							**1**	**1**
		E	**7**	**100**	**0**	**0**	-	**64**	**29**	**71**	**0**	**0**							**14**	**0**
28	Technology to freely apply organic, inorganic, and metal materials at the nano level.	1	**148**	**20**	**28**	**52**	-	**76**	**56**	**38**	**6**	**0**							**1**	**6**
		2	**127**	**17**	**27**	**56**	-	**78**	**58**	**39**	**3**	**0**							**1**	**2**
		E	**22**	**100**	**0**	**0**	-	**95**	**91**	**9**	**0**	**0**							**0**	**0**

Countries at the leading edge					Regarding technological realization												Time of social application							Regarding social application											
					Necessity of gov't involvement				Effective measures that should be taken by gov't															Necessity of gov't involvement				Effective measures that should be taken by gov't							
Japan	USA	EU	Asia	Other	High	Moderate	Low	None	Human resources development	Strengthened industry-academic-government and interdisciplinary collaboration	Development of R&D infrastructure	Expansion of R&D funding	Internationalization of R&D activities	Relaxation or elimination of relevant regulations	Tightened or new regulations	Other	2006–2010	2011–2015	2016–2025	2026–2035	2036–	Will not be applied	Do not know	High	Moderate	Low	None	Human resources development	Strengthened industry-academic-government and interdisciplinary collaboration	Improvement of environment for business startups	Support through taxation, subsidies, and procurement	Relaxation or elimination of relevant regulations	Tightened or new regulations	Other
(%)					(%)				(%)													(%)		(%)				(%)						
45	**48**	**6**	**0**	**1**	**18**	**45**	**22**	**15**	**46**	**36**	**43**	**58**	**3**	**4**	**1**	**0**						**11**	**19**	**12**	**43**	**29**	**16**	**46**	**42**	**26**	**33**	**11**	**4**	**0**
43	**57**	**0**	**0**	**0**	**7**	**66**	**22**	**5**	**51**	**35**	**30**	**67**	**0**	**1**	**0**	**0**						**5**	**7**	**4**	**64**	**24**	**8**	**60**	**64**	**10**	**23**	**2**	**1**	**0**
67	**33**	**0**	**0**	**0**	**0**	**83**	**0**	**17**	**40**	**40**	**20**	**80**	**0**	**0**	**0**	**0**						**33**	**0**	**17**	**66**	**0**	**17**	**40**	**40**	**0**	**60**	**0**	**0**	**0**
48	**42**	**10**	**0**	**0**	**21**	**43**	**25**	**11**	**40**	**45**	**42**	**60**	**4**	**4**	**1**	**0**						**4**	**9**	**12**	**42**	**32**	**14**	**43**	**53**	**31**	**40**	**7**	**2**	**0**
66	**34**	**0**	**0**	**0**	**10**	**71**	**15**	**4**	**34**	**57**	**29**	**70**	**0**	**1**	**0**	**0**						**1**	**1**	**7**	**63**	**25**	**5**	**47**	**84**	**16**	**35**	**1**	**1**	**0**
100	**0**	**0**	**0**	**0**	**14**	**58**	**14**	**14**	**17**	**67**	**17**	**50**	**0**	**0**	**0**	**0**						**14**	**0**	**0**	**43**	**43**	**14**	**33**	**50**	**67**	**33**	**0**	**0**	**0**
39	**52**	**8**	**0**	**1**	**34**	**42**	**17**	**7**	**44**	**48**	**46**	**71**	**8**	**2**	**1**	**0**						**1**	**7**	**20**	**46**	**23**	**11**	**48**	**54**	**33**	**37**	**6**	**3**	**0**
26	**74**	**0**	**0**	**0**	**18**	**68**	**11**	**3**	**44**	**53**	**38**	**75**	**1**	**1**	**0**	**0**						**1**	**2**	**9**	**69**	**15**	**7**	**48**	**82**	**14**	**37**	**2**	**2**	**1**
41	**59**	**0**	**0**	**0**	**36**	**64**	**0**	**0**	**41**	**45**	**41**	**82**	**0**	**0**	**0**	**0**						**0**	**0**	**32**	**49**	**14**	**5**	**29**	**76**	**10**	**48**	**5**	**5**	**5**

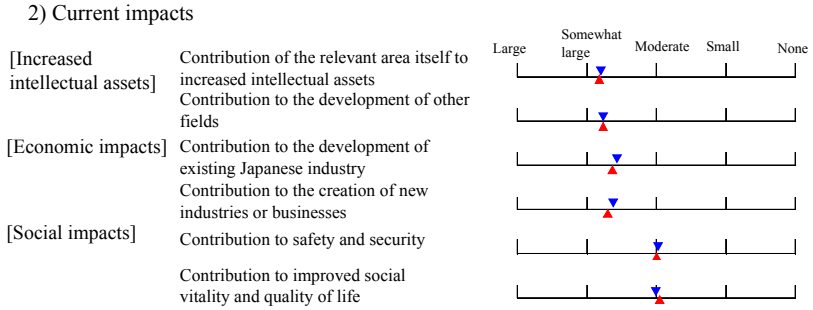
V. New materials from nanolevel structure control

1. Questions regarding the relevant area

1) Degree of expertise in the area

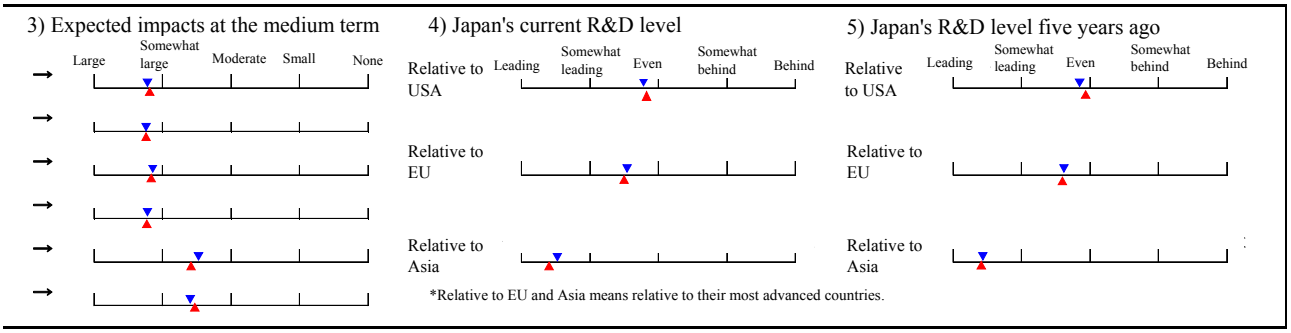


2) Current impacts



2. Questions regarding topics

No	Topic	Questionnaire	Respondents (persons)	Degree of expertise (%)				Importance to Japan (%)					Time of technological realization							
				High	Moderate	Low	None	Index	High	Moderate	Low	None	Already realized	2006–2010	2011–2015	2016–2025	2026–2035	2036–	Will not be realized (%)	Do not know (%)
29	Biomedical ceramics that function approximately the same as human bone.	1	**121**	**15**	**20**	**65**	-	**66**	**38**	**50**	**12**	**0**							**0**	**0**
		2	**106**	**5**	**18**	**77**	-	**61**	**24**	**72**	**4**	**0**							**0**	**2**
		E	**5**	**100**	**0**	**0**	-	**90**	**80**	**20**	**0**	**0**							**0**	**0**
30	All-organic ferromagnets with a Curie point above room temperature.	1	**83**	**7**	**25**	**68**	-	**57**	**27**	**50**	**22**	**1**							**5**	**14**
		2	**94**	**2**	**14**	**84**	-	**49**	**9**	**73**	**17**	**1**							**1**	**8**
		E	**2**	**100**	**0**	**0**	-	**100**	**100**	**0**	**0**	**0**							**0**	**0**
31	Macromolecule materials with conductivity and environment resistance equivalent to copper at room temperature.	1	**110**	**13**	**25**	**62**	-	**64**	**37**	**45**	**16**	**2**							**8**	**15**
		2	**105**	**6**	**22**	**72**	-	**58**	**21**	**71**	**7**	**1**							**5**	**5**
		E	**6**	**100**	**0**	**0**	-	**83**	**67**	**33**	**0**	**0**							**17**	**0**
32	Lead-free ferroelectrics with a piezoelectric modulus equivalent to PZT (Pb [Zr, Ti] O3).	1	**90**	**12**	**28**	**60**	-	**63**	**37**	**42**	**19**	**2**							**2**	**5**
		2	**94**	**4**	**22**	**74**	-	**53**	**16**	**67**	**16**	**1**							**0**	**0**
		E	**4**	**100**	**0**	**0**	-	**69**	**50**	**25**	**25**	**0**							**0**	**0**
33	Macromolecule superconducting materials with transfer points above liquid nitrogen temperature.	1	**104**	**13**	**21**	**66**	-	**61**	**34**	**46**	**16**	**4**							**10**	**19**
		2	**102**	**4**	**20**	**76**	-	**53**	**17**	**65**	**16**	**2**							**7**	**8**
		E	**4**	**100**	**0**	**0**	-	**69**	**50**	**25**	**25**	**0**							**25**	**25**
34	Heat resistant alloys that can bear a load of 15 kgf/mm2 (about 150 MPa) for 1,000 hours at a high (atmospheric) temperature of 1200°C.	1	**65**	**8**	**28**	**64**	-	**58**	**26**	**54**	**18**	**2**							**0**	**5**
		2	**74**	**3**	**20**	**77**	-	**53**	**14**	**74**	**11**	**1**							**0**	**4**
		E	**2**	**100**	**0**	**0**	-	**100**	**100**	**0**	**0**	**0**							**0**	**0**
35	Superconductors with transfer points at room temperature and above.	1	**108**	**16**	**22**	**62**	-	**79**	**65**	**23**	**10**	**2**							**11**	**27**
		2	**106**	**8**	**17**	**75**	-	**83**	**69**	**23**	**8**	**0**							**7**	**13**
		E	**8**	**100**	**0**	**0**	-	**91**	**87**	**0**	**13**	**0**							**13**	**38**
36	Anisotropic nanocomposite magnets with a (BH)max=400 kJ/m3(50.3 MGOe) or greater through nanometer-scale control of heterostructure.	1	**71**	**8**	**30**	**62**	-	**63**	**37**	**41**	**22**	**0**							**3**	**11**
		2	**76**	**3**	**12**	**85**	-	**58**	**21**	**70**	**9**	**0**							**0**	**4**
		E	**2**	**100**	**0**	**0**	-	**75**	**50**	**50**	**0**	**0**							**0**	**0**



Countries at the leading edge					Regarding technological realization													Time of social application							Regarding social application											
					Necessity of gov't involvement				Effective measures that should be taken by gov't																Necessity of gov't involvement				Effective measures that should be taken by gov't							
Japan	USA	EU	Asia	Other	High	Moderate	Low	None	Human resources development	Strengthened industry-academic-government and interdisciplinary collaboration	Development of R&D infrastructure	Expansion of R&D funding	Internationalization of R&D activities	Relaxation or elimination of relevant regulations	Tightened or new regulations	Other	2006–2010	2011–2015	2016–2025	2026–2035	2036–	Will not be applied	Do not know	High	Moderate	Low	None	Human resources development	Strengthened industry-academic-government and interdisciplinary collaboration	Improvement of environment for business startups	Support through taxation, subsidies, and procurement	Relaxation or elimination of relevant regulations	Tightened or new regulations	Other
(%)					(%)				(%)													(%)		(%)				(%)							
52	41	7	0	0	23	56	15	6	31	51	31	64	6	15	8	1						1	0	20	53	22	5	36	47	26	38	40	12	1
77	23	0	0	0	6	79	13	2	27	59	24	70	0	9	1	0						0	2	4	77	16	3	32	69	20	39	35	4	1
80	20	0	0	0	0	100	0	0	100	50	75	50	0	25	0	0						0	0	20	80	0	0	100	60	60	60	60	20	20
36	53	10	0	1	15	54	24	7	36	41	45	62	3	1	0	0						4	16	7	48	30	15	39	59	41	38	7	2	2
19	79	2	0	0	3	68	26	3	37	43	42	69	0	1	0	0						3	7	1	63	30	6	37	77	23	33	0	2	0
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39	56	5	0	0	21	44	26	9	41	47	36	64	5	1	0	1						8	16	9	50	29	12	35	57	32	35	8	5	1
21	77	2	0	0	6	68	23	3	40	53	31	71	0	1	0	0						5	5	2	69	21	8	34	80	20	36	1	1	0
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18	80	1	0	1	7	67	21	5	37	43	34	68	2	1	0	0						7	10	3	61	28	8	39	79	19	30	0	1	0
25	50	25	0	0	0	25	75	0	25	0	25	75	25	0	0	0						25	25	0	25	75	0	0	75	50	0	0	0	0
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47	42	9	0	2	32	38	20	10	42	29	49	58	11	1	0	2						7	32	23	32	29	16	38	51	28	40	11	4	1
63	36	1	0	0	15	57	21	7	53	26	45	69	2	1	0	0						9	15	13	48	26	13	50	68	19	41	2	2	0
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61	27	10	0	2	17	46	25	12	44	35	42	58	11	2	0	0						3	9	11	40	32	17	41	48	33	37	13	6	2
92	8	0	0	0	7	66	24	3	53	37	36	67	0	1	0	0						0	4	7	55	33	5	46	84	13	30	0	1	0
100	0	0	0	0	50	0	50	0	50	100	50	50	0	0	0	0						0	0	50	0	50	0	50	100	50	50	0	0	0

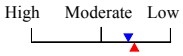
No	Topic	Questionnaire	Respondents (persons)	Degree of expertise (%)				Importance to Japan					Time of technological realization									
				High	Moderate	Low	None	Index	High	Moderate	Low	None	Already realized	2006–2010	2011–2015	2016–2025	2026–2035	2036–	Will not be realized (%)	Do not know (%)
37	Insulating materials with a dielectric constant of 1.3 or less for ultra-LSI.	1	**91**	**10**	**32**	**58**	**-**	**74**	**54**	**37**	**8**	**1**							**2**	**7**
		2	**90**	**9**	**22**	**69**	**-**	**82**	**67**	**29**	**3**	**1**							**1**	**0**
		E	**8**	**100**	**0**	**0**	**-**	**81**	**62**	**38**	**0**	**0**							**13**	**0**
38	Large-area amorphous silicon solar cells with a conversion efficiency above 20 percent.	1	**118**	**14**	**27**	**59**	**-**	**84**	**71**	**23**	**5**	**1**							**10**	**4**
		2	**104**	**8**	**25**	**67**	**-**	**88**	**78**	**18**	**3**	**1**							**5**	**1**
		E	**8**	**100**	**0**	**0**	**-**	**78**	**62**	**25**	**13**	**0**							**0**	**0**
39	Organic and inorganic compound materials that express new functions or innovative properties through structures controlled at the nanometer level.	1	**142**	**27**	**25**	**48**	**-**	**70**	**45**	**48**	**7**	**0**							**0**	**6**
		2	**133**	**18**	**28**	**54**	**-**	**67**	**37**	**59**	**4**	**0**							**0**	**2**
		E	**24**	**100**	**0**	**0**	**-**	**85**	**70**	**30**	**0**	**0**							**0**	**0**
40	Nanomaterials that show practical, meaningful stimulus response at necessary times and places.	1	**129**	**18**	**30**	**52**	**-**	**65**	**36**	**51**	**12**	**1**							**1**	**7**
		2	**117**	**15**	**30**	**55**	**-**	**60**	**25**	**68**	**6**	**1**							**0**	**2**
		E	**17**	**100**	**0**	**0**	**-**	**83**	**69**	**25**	**6**	**0**							**0**	**0**
41	Semiconductor diamonds at a practical level.	1	**94**	**9**	**30**	**61**	**-**	**59**	**28**	**52**	**20**	**0**							**2**	**5**
		2	**88**	**5**	**19**	**76**	**-**	**53**	**14**	**69**	**17**	**0**							**0**	**2**
		E	**4**	**100**	**0**	**0**	**-**	**63**	**25**	**75**	**0**	**0**							**0**	**0**
42	Light and composite structure materials from carbon nanotubes.	1	**113**	**14**	**32**	**54**	**-**	**61**	**30**	**52**	**18**	**0**							**1**	**2**
		2	**110**	**6**	**29**	**65**	**-**	**55**	**16**	**72**	**12**	**0**							**0**	**0**
		E	**7**	**100**	**0**	**0**	**-**	**57**	**29**	**42**	**29**	**0**							**0**	**0**

Countries at the leading edge					Regarding technological realization												Time of social application							Regarding social application													
					Necessity of gov't involvement				Effective measures that should be taken by gov't															Necessity of gov't involvement				Effective measures that should be taken by gov't								
Japan	USA	EU	Asia	Other	High	Moderate	Low	None	Human resources development	Strengthened industry-academic-government and interdisciplinary collaboration	Development of R&D infrastructure	Expansion of R&D funding	Internationalization of R&D activities	Relaxation or elimination of relevant regulations	Tightened or new regulations	Other	2006–2010	2011–2015	2016–2025	2026–2035	2036–	Will not be applied	Do not know	High	Moderate	Low	None	Human resources development	Strengthened industry-academic-government and interdisciplinary collaboration	Improvement of environment for business startups	Support through taxation, subsidies, and procurement	Relaxation or elimination of relevant regulations	Tightened or new regulations	Other
(%)					(%)				(%)													(%)		(%)				(%)							
49	49	1	0	1	27	43	19	11	35	52	37	61	13	3	0	1						1	5	22	32	31	15	33	65	28	39	9	4	0
67	33	0	0	0	9	69	20	2	30	64	28	76	2	1	0	1						1	0	7	58	26	9	26	86	15	45	1	3	1
100	0	0	0	0	38	49	13	0	25	63	50	63	13	0	0	13						14	0	13	74	0	13	14	71	29	29	0	0	14
88	11	1	0	0	36	42	14	8	30	60	32	68	10	5	4	0						7	7	28	42	22	8	28	46	28	52	20	15	0
100	0	0	0	0	23	56	16	5	29	67	24	76	1	1	0	0						5	1	21	53	21	5	26	65	24	66	12	7	0
100	0	0	0	0	36	38	13	13	57	57	43	71	0	0	0	0						0	0	36	13	38	13	14	57	29	71	14	14	0
43	49	6	0	2	31	46	18	5	46	42	42	65	8	3	1	1						1	10	20	46	22	12	50	59	33	32	8	3	0
39	59	1	1	0	14	72	12	2	54	51	33	75	2	1	0	0						0	2	7	66	22	5	47	81	23	31	3	2	2
54	46	0	0	0	33	63	4	0	54	54	38	75	8	0	0	0						0	0	21	62	17	0	50	79	21	46	17	4	4
50	43	5	0	2	28	44	22	6	48	44	36	63	8	5	2	2						3	9	18	49	20	13	45	63	29	36	14	5	0
62	37	1	0	0	12	76	11	1	51	51	30	72	2	1	0	0						0	2	8	70	20	2	40	78	25	30	6	2	2
71	29	0	0	0	35	59	6	0	41	65	29	82	0	0	0	0						0	0	25	62	13	0	38	81	31	25	6	0	0
58	34	8	0	1	22	51	20	7	47	53	30	62	9	3	1	0						2	5	14	46	26	14	47	64	36	38	7	3	1
90	9	1	0	0	3	69	26	2	39	60	24	69	0	1	0	0						1	0	2	61	29	8	36	88	20	33	4	4	1
100	0	0	0	0	25	50	25	0	100	50	50	75	0	0	0	0						0	0	34	33	0	33	50	100	50	50	0	0	0
71	27	0	2	0	24	39	30	7	38	57	38	59	5	3	0	2						1	2	14	45	30	11	37	60	39	37	12	4	1
88	11	1	0	0	4	66	29	1	33	71	29	65	0	1	0	0						0	0	3	66	27	4	27	80	33	40	5	2	1
57	43	0	0	0	14	57	29	0	29	71	29	57	0	0	0	0						0	0	14	57	29	0	29	71	14	43	0	0	0

VI. Nano devices and sensors

1. Questions regarding the relevant area

1) Degree of expertise in the area

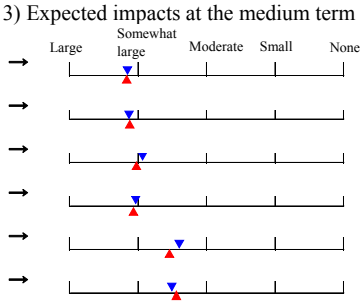


2) Current impacts

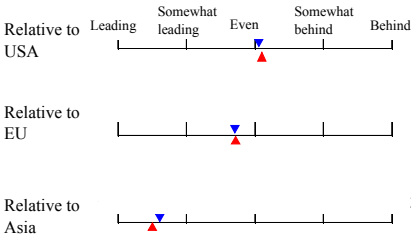
2. Questions regarding topics

No	Topic	Questionnaire	Respondents (persons)	Degree of expertise (%)				Importance to Japan					Time of technological realization							
				High	Moderate	Low	None	Index	High	Moderate	Low	None	Already realized	2006–2010	2011–2015	2016–2025	2026–2035	2036–	Will not be realized	Do not know
43	Single-electron memory devices	1	**104**	**17**	**25**	**58**	**-**	**68**	**42**	**47**	**9**	**2**							**6**	**8**
		2	**100**	**6**	**31**	**63**	**-**	**60**	**27**	**62**	**8**	**3**							**7**	**0**
		E	**6**	**100**	**0**	**0**	**-**	**29**	**0**	**50**	**17**	**33**							**40**	**0**
44	Devices that utilize the switching functions of single molecules and atoms.	1	**118**	**17**	**29**	**54**	**-**	**71**	**47**	**43**	**8**	**2**							**3**	**9**
		2	**111**	**9**	**29**	**62**	**-**	**68**	**43**	**47**	**7**	**3**							**3**	**3**
		E	**10**	**100**	**0**	**0**	**-**	**90**	**80**	**20**	**0**	**0**							**0**	**0**
45	Molecular devices and sensors that use protein or DNA as elements.	1	**124**	**16**	**27**	**57**	**-**	**69**	**44**	**44**	**11**	**1**							**1**	**4**
		2	**119**	**10**	**24**	**66**	**-**	**70**	**41**	**55**	**3**	**1**							**0**	**2**
		E	**12**	**100**	**0**	**0**	**-**	**96**	**92**	**8**	**0**	**0**							**0**	**0**
46	Ultrahigh-speed optical switching devices with an order of femtosecond switching time.	1	**93**	**12**	**32**	**56**	**-**	**70**	**45**	**47**	**7**	**1**							**0**	**7**
		2	**93**	**3**	**30**	**67**	**-**	**62**	**29**	**63**	**7**	**1**							**0**	**0**
		E	**3**	**100**	**0**	**0**	**-**	**33**	**0**	**67**	**0**	**33**							**0**	**0**
47	Devices and sensors manufactured with nanometer precision.	1	**123**	**23**	**31**	**46**	**-**	**75**	**54**	**38**	**8**	**0**							**0**	**4**
		2	**115**	**13**	**37**	**50**	**-**	**80**	**62**	**33**	**4**	**1**							**0**	**0**
		E	**15**	**100**	**0**	**0**	**-**	**90**	**80**	**20**	**0**	**0**							**0**	**0**
48	Technology that measures/controls spin polarization at the atomic and molecular levels.	1	**90**	**14**	**17**	**69**	**-**	**62**	**33**	**48**	**19**	**0**							**1**	**9**
		2	**95**	**6**	**20**	**74**	**-**	**59**	**22**	**69**	**9**	**0**							**0**	**2**
		E	**6**	**100**	**0**	**0**	**-**	**75**	**50**	**50**	**0**	**0**							**0**	**0**

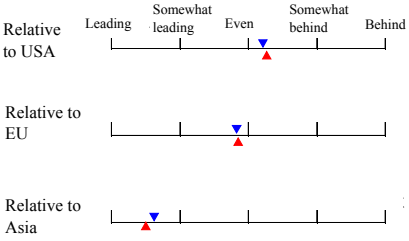
3) Expected impacts at the medium term



4) Japan's current R&D level



5) Japan's R&D level five years ago



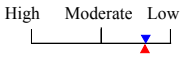
*Relative to EU and Asia means relative to their most advanced countries.

Countries at the leading edge					Regarding technological realization												Time of social application							Regarding social application											
					Necessity of gov't involvement				Effective measures that should be taken by gov't															Necessity of gov't involvement				Effective measures that should be taken by gov't						
Japan	USA	EU	Asia	Other	High	Moderate	Low	None	Human resources development	Strengthened industry-academic-government and interdisciplinary collaboration	Development of R&D infrastructure	Expansion of R&D funding	Internationalization of R&D activities	Relaxation or elimination of relevant regulations	Tightened or new regulations	Other	2006–2010	2011–2015	2016–2025	2026–2035	2036–	Will not be applied	Do not know	High	Moderate	Low	None	Human resources development	Strengthened industry-academic-government and interdisciplinary collaboration	Improvement of environment for business startups	Support through taxation, subsidies, and procurement	Relaxation or elimination of relevant regulations	Tightened or new regulations	Other
(%)					(%)				(%)													(%)		(%)				(%)						
42	48	10	0	0	22	53	17	8	49	47	35	65	15	2	1	0						6	13	16	43	25	16	44	58	25	39	9	4	0
42	57	1	0	0	11	65	18	6	52	44	28	73	3	1	0	0						8	1	6	57	25	12	48	81	15	30	0	1	0
80	20	0	0	0	0	20	40	40	33	33	33	67	0	0	0	0						40	0	0	20	20	60	0	50	50	0	0	0	0
23	70	6	0	1	30	45	18	7	50	36	41	65	11	3	0	0						4	15	21	37	29	13	42	58	18	38	10	2	0
11	88	0	1	0	16	65	16	3	60	33	37	77	4	1	0	0						5	2	9	63	21	7	51	78	13	38	1	1	0
10	90	0	0	0	30	60	10	0	70	30	50	80	0	0	0	0						0	0	20	60	10	10	88	75	13	50	0	0	0
24	72	4	0	0	34	46	17	3	44	49	33	68	11	4	1	0						1	8	24	41	29	6	42	56	32	37	15	3	0
7	93	0	0	0	20	69	10	1	43	50	30	72	0	2	0	0						0	2	13	69	14	4	48	82	20	32	5	1	0
17	83	0	0	0	42	50	8	0	67	42	25	83	0	0	0	0						0	0	33	50	17	0	75	67	25	58	0	0	0
38	59	2	0	1	26	52	17	5	35	43	30	69	8	1	0	0						0	8	23	44	25	8	37	67	26	39	7	4	1
24	75	1	0	0	7	76	16	1	34	51	21	78	3	1	0	0						0	0	5	70	19	6	36	81	15	43	1	1	0
100	0	0	0	0	0	0	100	0	50	50	0	50	0	0	0	0						0	0	0	50	50	0	0	50	100	0	0	0	0
33	58	7	1	1	36	46	16	2	44	48	39	70	10	2	0	0						0	5	32	36	24	8	46	58	28	42	5	2	0
16	83	1	0	0	18	68	14	0	44	53	27	77	2	1	0	0						0	1	12	65	18	5	41	81	21	46	3	2	1
27	73	0	0	0	40	47	13	0	60	60	47	80	0	0	0	0						0	0	41	33	13	13	54	77	23	46	8	0	0
38	55	7	0	0	23	49	24	4	48	37	33	66	10	1	0	0						1	16	18	38	35	9	51	44	22	47	6	1	0
12	87	1	0	0	9	74	16	1	55	30	33	78	2	1	0	0						0	3	8	63	25	4	60	62	11	44	1	1	0
17	83	0	0	0	17	49	17	17	40	20	60	80	0	0	0	0						0	0	17	49	17	17	80	60	20	20	0	0	0

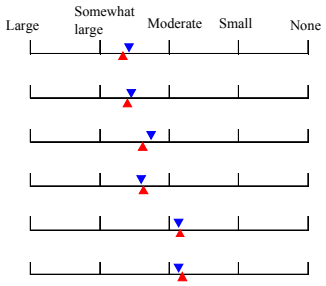
VII. NEMS technology

1. Questions regarding the relevant area

1) Degree of expertise in the area

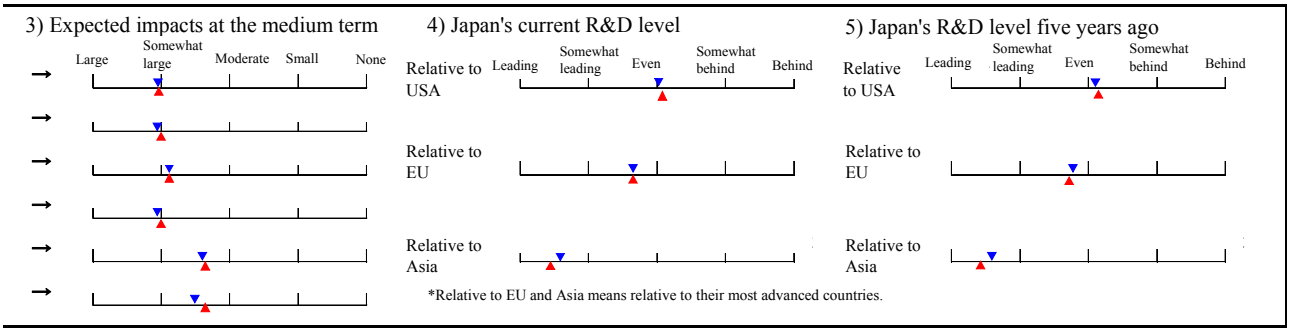


2) Current impacts



2. Questions regarding topics

No	Topic	Questionnaire	Respondents (persons)	Degree of expertise (%)				Importance to Japan					Time of technological realization							
				High	Moderate	Low	None	Index	High	Moderate	Low	None	Already realized	2006–2010	2011–2015	2016–2025	2026–2035	2036–	Will not be realized (%)	Do not know (%)
49	NEMS that uses Brownian motion as its motive energy.	1	**70**	**7**	**21**	**72**	-	**52**	**22**	**47**	**27**	**4**							**6**	**12**
		2	**75**	**4**	**11**	**85**	-	**48**	**11**	**62**	**24**	**3**							**3**	**11**
		E	**3**	**100**	**0**	**0**	-	**50**	**0**	**100**	**0**	**0**							**0**	**0**
50	Nanosurgery manipulators (manipulators that directly manipulate, excise, join, and process biomolecules) for biomolecules.	1	**84**	**11**	**29**	**60**	-	**66**	**43**	**39**	**16**	**2**							**2**	**7**
		2	**90**	**7**	**18**	**75**	-	**74**	**52**	**40**	**8**	**0**							**0**	**7**
		E	**6**	**100**	**0**	**0**	-	**100**	**100**	**0**	**0**	**0**							**0**	**0**
51	Mechanical switching elements that operate at 10 GHz and above and have outstanding ON/OFF characteristics.	1	**71**	**13**	**27**	**60**	-	**57**	**28**	**44**	**27**	**1**							**1**	**15**
		2	**80**	**1**	**24**	**75**	-	**52**	**15**	**67**	**14**	**4**							**3**	**4**
		E	**1**	**100**	**0**	**0**	-	**100**	**100**	**0**	**0**	**0**							**0**	**0**
52	Multi-nanoprobe spectroscopic analysis, processing control, and operating technology that enables multi-sensing and multi-processing at the nanometer level of the functional structure of biomolecules such as nano semiconductor devices, molecular devices,	1	**124**	**15**	**29**	**56**	-	**69**	**45**	**43**	**11**	**1**							**1**	**7**
		2	**114**	**14**	**19**	**67**	-	**70**	**44**	**50**	**5**	**1**							**0**	**2**
		E	**16**	**100**	**0**	**0**	-	**100**	**100**	**0**	**0**	**0**							**0**	**0**
53	Probe array-type sensor elements sensitive enough to detect single molecules.	1	**104**	**14**	**25**	**61**	-	**65**	**37**	**50**	**12**	**1**							**2**	**10**
		2	**102**	**11**	**17**	**72**	-	**55**	**16**	**74**	**10**	**0**							**1**	**5**
		E	**11**	**100**	**0**	**0**	-	**75**	**55**	**36**	**9**	**0**							**9**	**0**

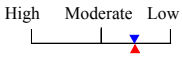


Countries at the leading edge					Regarding technological realization												Time of social application							Regarding social application											
					Necessity of gov't involvement				Effective measures that should be taken by gov't															Necessity of gov't involvement				Effective measures that should be taken by gov't						
Japan	USA	EU	Asia	Other	High	Moderate	Low	None	Human resources development	Strengthened industry-academic-government and interdisciplinary collaboration	Development of R&D infrastructure	Expansion of R&D funding	Internationalization of R&D activities	Relaxation or elimination of relevant regulations	Tightened or new regulations	Other	2006–2010	2011–2015	2016–2025	2026–2035	2036–	Will not be applied	Do not know	High	Moderate	Low	None	Human resources development	Strengthened industry-academic-government and interdisciplinary collaboration	Improvement of environment for business startups	Support through taxation, subsidies, and procurement	Relaxation or elimination of relevant regulations	Tightened or new regulations	Other
(%)					(%)				(%)													(%)		(%)				(%)						
25	62	6	2	5	21	50	19	10	49	39	47	49	4	4	0	0						5	14	11	50	28	11	44	54	30	30	11	2	2
8	91	1	0	0	8	67	24	1	63	29	39	61	0	3	0	0						3	11	3	63	28	6	53	75	16	28	1	1	1
67	33	0	0	0	67	33	0	0	100	67	33	100	0	0	0	0						0	33	33	67	0	0	100	67	67	100	0	0	0
31	60	6	0	3	31	39	26	4	45	45	47	66	5	9	0	0						1	10	24	37	32	7	44	56	30	32	23	4	1
11	89	0	0	0	18	61	20	1	53	43	40	70	0	3	0	0						0	8	11	66	20	3	55	78	27	30	10	1	0
67	33	0	0	0	67	0	33	0	67	50	50	100	0	17	0	0						0	17	34	33	33	0	67	67	67	83	33	0	0
41	54	5	0	0	17	53	25	5	32	50	39	65	3	2	0	0						1	16	13	43	33	11	36	59	32	41	5	2	0
19	78	3	0	0	6	68	23	3	36	57	27	72	0	1	0	0						1	4	5	61	26	8	39	79	23	32	0	1	0
100	0	0	0	0	100	0	0	0	100	100	100	100	0	0	0	0						0	0	100	0	0	0	100	100	100	100	0	0	0
30	60	10	0	0	32	50	16	2	45	50	46	69	8	4	0	0						1	9	18	45	30	7	47	54	42	45	12	1	0
12	87	1	0	0	17	69	14	0	46	59	37	74	2	1	0	0						0	3	10	67	19	4	52	81	25	43	2	1	0
31	69	0	0	0	56	38	6	0	75	75	56	100	0	0	0	0						0	0	19	68	13	0	75	81	56	69	6	0	0
16	66	17	0	1	26	54	18	2	41	47	39	63	7	3	0	0						2	11	20	46	25	9	42	57	32	39	12	4	1
6	87	7	0	0	11	71	17	1	46	51	31	70	1	2	1	0						1	5	7	66	22	5	52	74	24	35	1	1	0
9	55	36	0	0	46	36	18	0	73	55	45	100	0	0	0	0						9	0	36	46	9	9	80	70	70	60	0	0	0

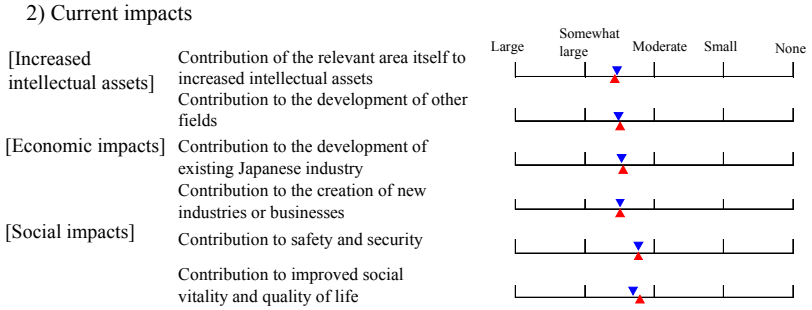
VIII. Environment and energy materials

1. Questions regarding the relevant area

1) Degree of expertise in the area

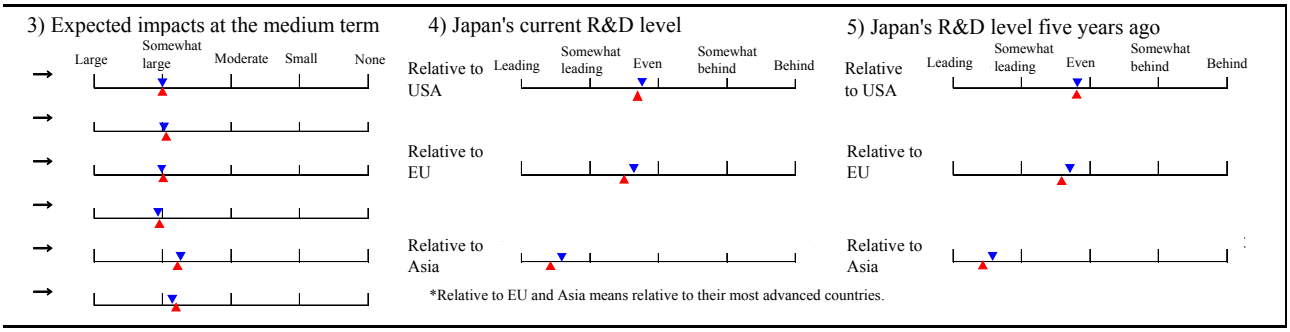


2) Current impacts



2. Questions regarding topics

No	Topic	Questionnaire	Respondents (persons)	Degree of expertise (%)				Importance to Japan					Time of technological realization							
				High	Moderate	Low	None	Index	High	Moderate	Low	None	Already realized	2006–2010	2011–2015	2016–2025	2026–2035	2036–	Will not be realized (%)	Do not know (%)
54	Direct catalytic production of hydrogen from methane at low temperature	1	92	21	24	55	-	71	49	39	11	1							2	4
		2	97	11	27	62	-	81	67	27	5	1							1	1
		E	11	100	0	0	-	86	82	9	0	9							9	0
55	Hydrogen production processes through photocatalytic decomposition of water with sunlight	1	104	20	18	62	-	76	57	31	12	0							1	5
		2	110	13	22	65	-	88	77	18	4	1							1	4
		E	14	100	0	0	-	89	79	21	0	0							7	7
56	Production of iron by a new economical method with hydrogen as reductant instead of coke.	1	67	12	18	70	-	57	26	56	13	5							3	8
		2	77	9	10	81	-	53	12	77	11	0							0	1
		E	7	100	0	0	-	68	43	43	14	0							0	0
57	Catalytic fixation of carbon dioxide that will solve one of the global environmental problems.	1	102	17	24	59	-	70	47	43	6	4							3	9
		2	99	11	16	73	-	77	59	33	5	3							2	3
		E	11	100	0	0	-	70	64	9	9	18							9	0
58	Complete control of nanopores in separation membranes.	1	109	14	28	58	-	57	25	56	18	1							0	5
		2	103	11	25	64	-	55	15	77	8	0							0	2
		E	11	100	0	0	-	82	64	36	0	0							0	0



Countries at the leading edge					Regarding technological realization													Time of social application							Regarding social application													
					Necessity of gov't involvement				Effective measures that should be taken by gov't																Necessity of gov't involvement				Effective measures that should be taken by gov't									
Japan	USA	EU	Asia	Other	High	Moderate	Low	None	Human resources development	Strengthened industry-academic-government and interdisciplinary collaboration	Development of R&D infrastructure	Expansion of R&D funding	Internationalization of R&D activities	Relaxation or elimination of relevant regulations	Tightened or new regulations	Other	2006–2010	2011–2015	2016–2025	2026–2035	2036–	Will not be applied	Do not know	High	Moderate	Low	None	Human resources development	Strengthened industry-academic-government and interdisciplinary collaboration	Improvement of environment for business startups	Support through taxation, subsidies, and procurement	Relaxation or elimination of relevant regulations	Tightened or new regulations	Other
(%)					(%)				(%)													(%)		(%)				(%)							
51	42	5	1	1	36	49	10	5	31	41	41	67	8	8	4	0						3	8	33	41	18	8	39	51	29	45	25	8	1
75	23	1	1	0	25	67	6	2	31	57	36	79	1	3	1	0						1	3	21	66	9	4	29	75	19	55	17	3	1
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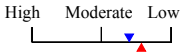
IX. Nanobiology

1. Questions regarding the relevant area

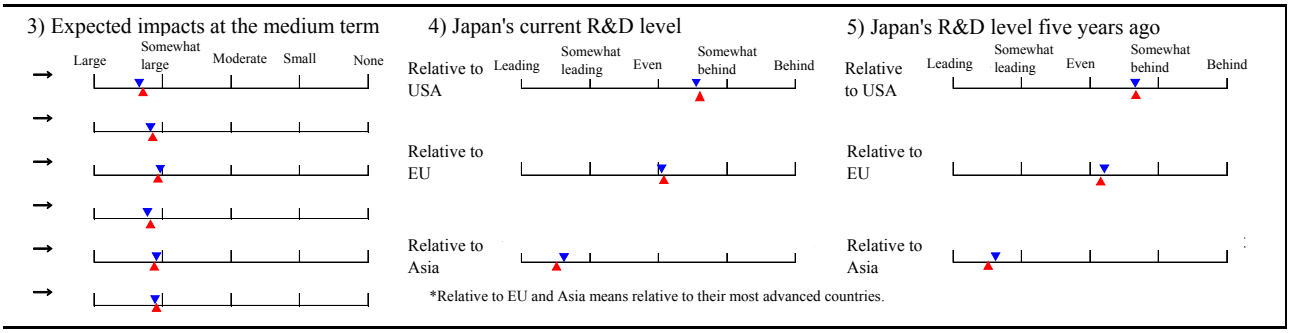
1) Degree of expertise in the area



2) Current impacts

2. Questions regarding topics

No	Topic	Questionnaire	Respondents (persons)	Degree of expertise (%)				Importance to Japan					Time of technological realization							
				High	Moderate	Low	None	Index	High	Moderate	Low	None	Already realized	2006–2010	2011–2015	2016–2025	2026–2035	2036–	Will not be realized (%)	Do not know (%)
59	Technology to predict three-dimensional structure from the primary sequence structure of proteins with about 30,000 molecules.	1	**88**	**9**	**24**	**67**	**-**	**63**	**34**	**52**	**14**	**0**							**0**	**7**
		2	**92**	**4**	**18**	**78**	**-**	**56**	**16**	**76**	**8**	**0**							**0**	**0**
		E	**4**	**100**	**0**	**0**	**-**	**75**	**50**	**50**	**0**	**0**							**0**	**0**
60	Actuators made from intelligent materials that can be utilized in medical devices for the in vivo use such as microsurgery.	1	**105**	**12**	**27**	**61**	**-**	**68**	**40**	**50**	**10**	**0**							**0**	**3**
		2	**99**	**8**	**29**	**63**	**-**	**66**	**34**	**63**	**3**	**0**							**0**	**1**
		E	**8**	**100**	**0**	**0**	**-**	**81**	**62**	**38**	**0**	**0**							**0**	**0**
61	Hybrid-type artificial organs with self-organized tissue derived from stem cells.	1	**101**	**18**	**27**	**55**	**-**	**71**	**47**	**45**	**8**	**0**							**0**	**6**
		2	**100**	**13**	**19**	**68**	**-**	**76**	**54**	**43**	**3**	**0**							**0**	**2**
		E	**13**	**100**	**0**	**0**	**-**	**96**	**92**	**8**	**0**	**0**							**0**	**0**
62	Nanocarrier systems that deliver drugs and genes to target cells in the body and are directed by outside signals.	1	**116**	**33**	**22**	**45**	**-**	**74**	**52**	**41**	**7**	**0**							**1**	**1**
		2	**115**	**17**	**27**	**56**	**-**	**83**	**68**	**28**	**4**	**0**							**0**	**0**
		E	**20**	**100**	**0**	**0**	**-**	**98**	**95**	**5**	**0**	**0**							**0**	**0**
63	Cell tissue sensors (biosensors composed of cells and tissue) used in place of animal experimentation.	1	**90**	**17**	**27**	**56**	**-**	**65**	**40**	**39**	**21**	**0**							**2**	**2**
		2	**97**	**9**	**23**	**68**	**-**	**68**	**41**	**47**	**12**	**0**							**0**	**0**
		E	**9**	**100**	**0**	**0**	**-**	**94**	**89**	**11**	**0**	**0**							**0**	**0**
64	Biocomputer devices utilizing cultured nerve cell networks.	1	**81**	**10**	**20**	**70**	**-**	**51**	**19**	**48**	**29**	**4**							**9**	**8**
		2	**85**	**5**	**9**	**86**	**-**	**51**	**14**	**62**	**23**	**1**							**5**	**4**
		E	**4**	**100**	**0**	**0**	**-**	**75**	**50**	**50**	**0**	**0**							**0**	**0**
65	Biochip diagnostic systems that can accurately diagnose onset risk for cancer and other serious diseases and supply information for setting treatment within a very short time.	1	**115**	**20**	**19**	**61**	**-**	**81**	**63**	**32**	**5**	**0**							**0**	**2**
		2	**106**	**14**	**19**	**67**	**-**	**87**	**76**	**20**	**4**	**0**							**0**	**2**
		E	**15**	**100**	**0**	**0**	**-**	**100**	**100**	**0**	**0**	**0**							**0**	**0**



Countries at the leading edge					Regarding technological realization														Time of social application							Regarding social application													
					Necessity of gov't involvement				Effective measures that should be taken by gov't																	Necessity of gov't involvement				Effective measures that should be taken by gov't									
Japan	USA	EU	Asia	Other	High	Moderate	Low	None	Human resources development	Strengthened industry-academic-government and interdisciplinary collaboration	Development of R&D infrastructure	Expansion of R&D funding	Internationalization of R&D activities	Relaxation or elimination of relevant regulations	Tightened or new regulations	Other	2006–2010	2011–2015	2016–2025	2026–2035	2036–	Will not be applied	Do not know	High	Moderate	Low	None	Human resources development	Strengthened industry-academic-government and interdisciplinary collaboration	Improvement of environment for business startups	Support through taxation, subsidies, and procurement	Relaxation or elimination of relevant regulations	Tightened or new regulations	Other
(%)					(%)				(%)													(%)		(%)				(%)							
17	78	4	0	1	24	57	13	6	37	36	44	63	8	5	1	0						0	8	17	52	18	13	42	53	29	40	10	1	0
4	95	1	0	0	12	72	13	3	44	35	42	70	1	3	1	0						0	1	9	69	16	6	44	76	19	42	0	1	0
0	100	0	0	0	50	50	0	0	75	25	50	100	0	0	0	0						0	25	50	50	0	0	75	25	50	75	0	0	0
32	64	3	0	1	29	54	16	1	39	48	38	68	7	17	2	0						0	4	19	56	22	3	40	52	31	41	27	10	1
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11	89	0	0	0	41	49	8	2	50	60	36	74	1	19	1	0						0	1	35	51	13	1	40	77	26	37	36	11	1
46	54	0	0	0	92	8	0	0	77	54	62	77	0	46	0	0						0	0	69	31	0	0	46	77	46	31	38	8	0
33	64	3	0	0	41	45	11	3	42	55	42	66	9	21	4	0						2	2	37	45	15	3	32	52	33	41	49	13	0
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17	76	6	0	1	34	45	19	2	38	49	37	67	14	17	2	0						0	4	31	43	22	4	38	49	28	37	36	16	1
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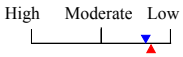
20	80	0	0	0	73	27	0	0	67	60	33	87	0	7	0	0						0	0	67	33	0	0	40	80	47	40	33	7	0

X. Nanoscience for a safe and secure society

1. Questions regarding the relevant area

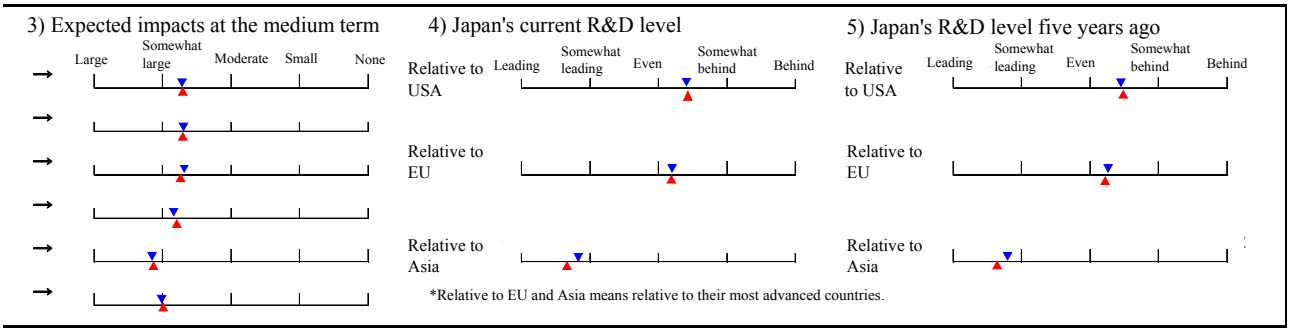
1) Degree of expertise in the area



2) Current impacts

2. Questions regarding topics

No	Topic	Questionnaire	Respondents (persons)	Degree of expertise (%)				Importance to Japan					Time of technological realization									
				High	Moderate	Low	None	Index	High	Moderate	Low	None	Already realized	2006–2010	2011–2015	2016–2025	2026–2035	2036–	Will not be realized	Do not know		
																					(%)	
66	Establishment of safety standards for DDS capsule materials and doses.	1	**90**	**14**	**21**	**65**	-	**72**	**52**	**34**	**13**	**1**										
		2	**94**	**4**	**16**	**80**	-	**82**	**67**	**26**	**6**	**1**										
		E	**4**	**100**	**0**	**0**	-	**100**	**100**	**0**	**0**	**0**										
67	Establishment of safety standards for nanoparticles in consumer goods such as cosmetics and foods.	1	**105**	**10**	**20**	**70**	-	**68**	**45**	**39**	**16**	**0**										
		2	**100**	**3**	**20**	**77**	-	**73**	**52**	**37**	**10**	**1**										
		E	**3**	**100**	**0**	**0**	-	**83**	**67**	**33**	**0**	**0**										
68	Establishment of manufacturing standards for diagnostic DNA and protein chips.	1	**93**	**14**	**15**	**71**	-	**71**	**51**	**33**	**14**	**2**										
		2	**96**	**3**	**19**	**78**	-	**76**	**59**	**31**	**8**	**2**										
		E	**3**	**100**	**0**	**0**	-	**100**	**100**	**0**	**0**	**0**										
69	Advanced authentication technology utilizing DNA tags.	1	**83**	**5**	**20**	**75**	-	**59**	**35**	**35**	**26**	**4**									**3**	**3**
		2	**92**	**3**	**15**	**82**	-	**61**	**28**	**62**	**8**	**2**									**0**	**1**
		E	**3**	**100**	**0**	**0**	-	**83**	**67**	**33**	**0**	**0**									**0**	**0**
70	Virus detection technology utilizing protein chips with activity equivalent to that of life forms.	1	**79**	**11**	**18**	**71**	-	**67**	**43**	**43**	**13**	**1**									**0**	**5**
		2	**91**	**9**	**15**	**76**	-	**72**	**47**	**49**	**3**	**1**									**0**	**0**
		E	**8**	**100**	**0**	**0**	-	**94**	**87**	**13**	**0**	**0**									**0**	**0**



Countries at the leading edge					Regarding technological realization												Time of social application							Regarding social application													
					Necessity of gov't involvement				Effective measures that should be taken by gov't															Necessity of gov't involvement				Effective measures that should be taken by gov't									
Japan	USA	EU	Asia	Other	High	Moderate	Low	None	Human resources development	Strengthened industry-academic-government and interdisciplinary collaboration	Development of R&D infrastructure	Expansion of R&D funding	Internationalization of R&D activities	Relaxation or elimination of relevant regulations	Tightened or new regulations	Other	2006–2010	2011–2015	2016–2025	2026–2035	2036–	Will not be applied	Do not know	High	Moderate	Low	None	Human resources development	Strengthened industry-academic-government and interdisciplinary collaboration	Improvement of environment for business startups	Support through taxation, subsidies, and procurement	Relaxation or elimination of relevant regulations	Tightened or new regulations	Other
(%)					(%)				(%)													(%)		(%)				(%)							
																						0	1	60	32	8	0	31	46	19	16	41	46	0
																						0	1	74	19	7	0	32	68	10	10	44	48	0
																						0	0	100	0	0	0	0	67	33	0	100	0	0
																						1	3	51	32	16	1	32	43	17	16	37	49	2
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4	91	1	0	4	27	40	25	8	43	42	45	49	9	9	12	0						3	4	32	39	22	7	38	45	25	34	31	32	3
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14	86	0	0	0	75	25	0	0	63	63	50	88	0	0	0	0						0	13	38	62	0	0	63	63	38	50	0	0	0