

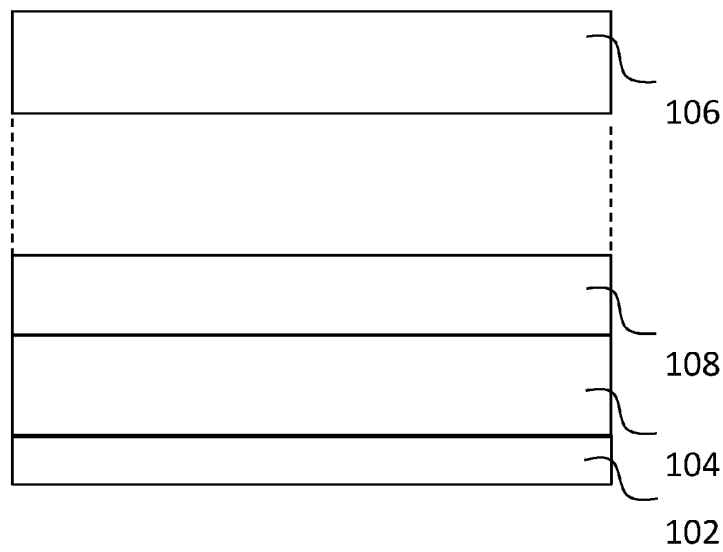
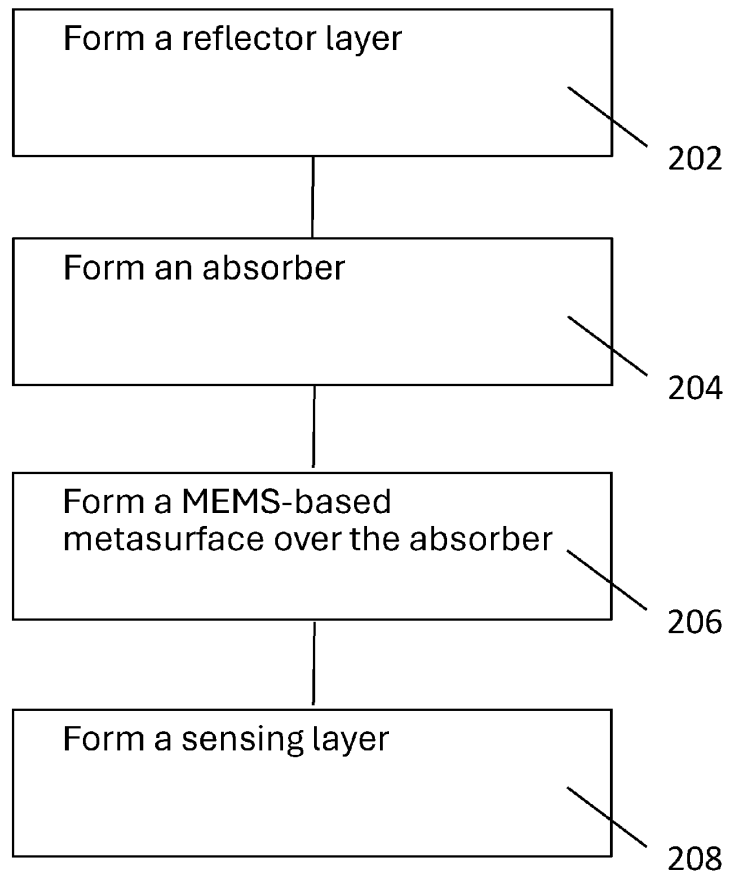


FIG. 1

**FIG. 2**

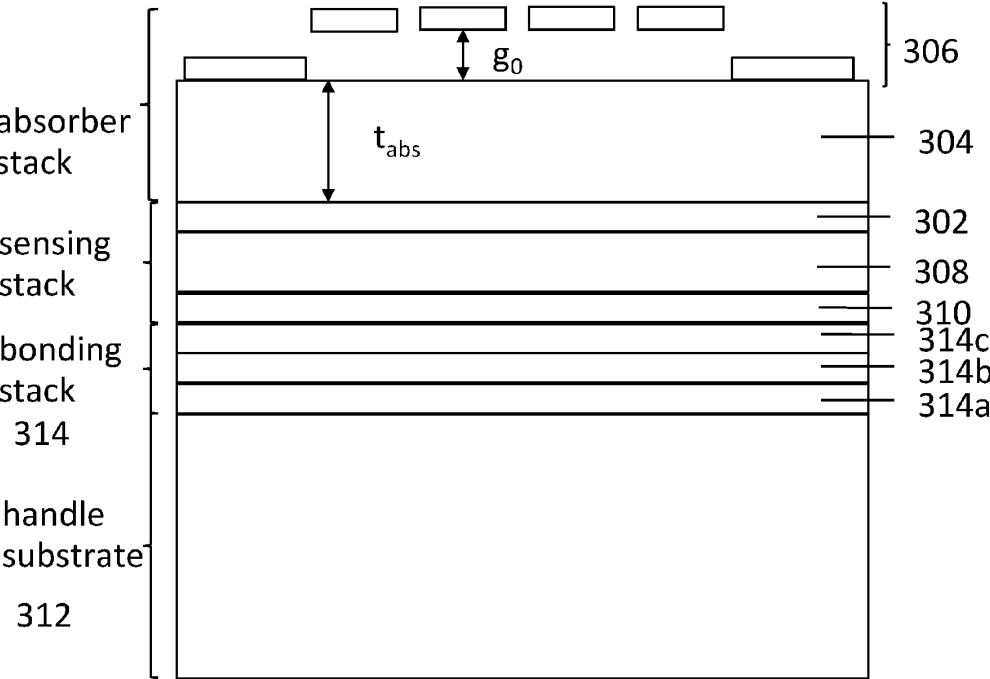


FIG. 3A

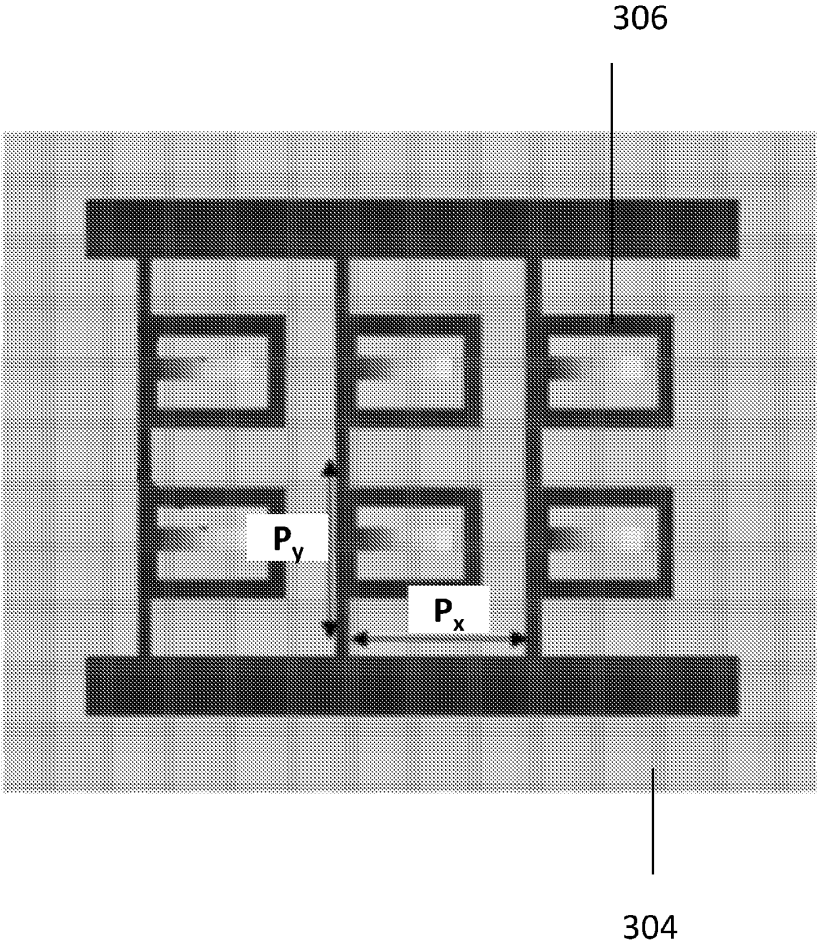


FIG. 3B

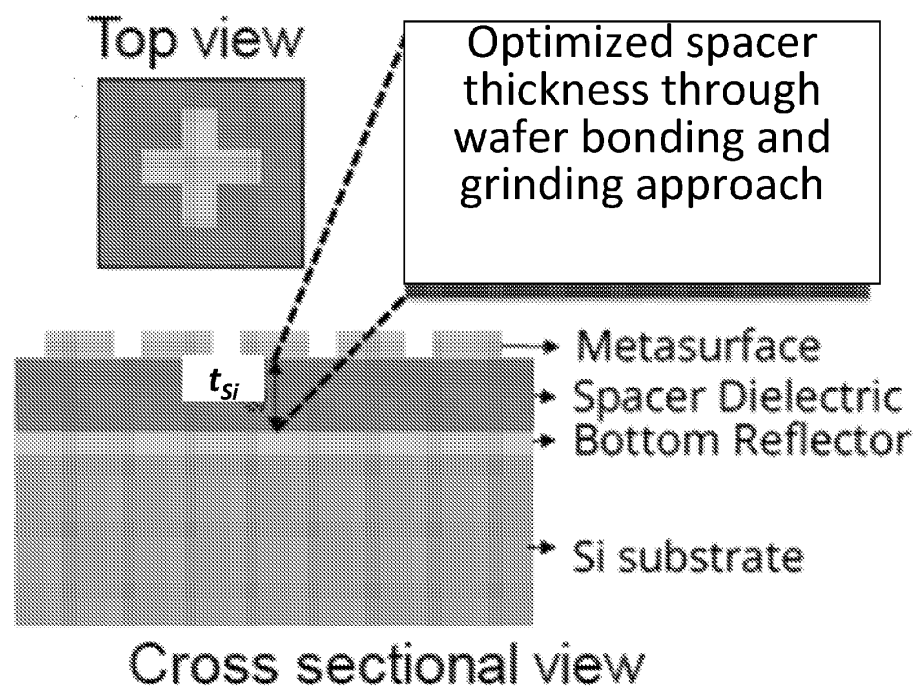


FIG. 4A

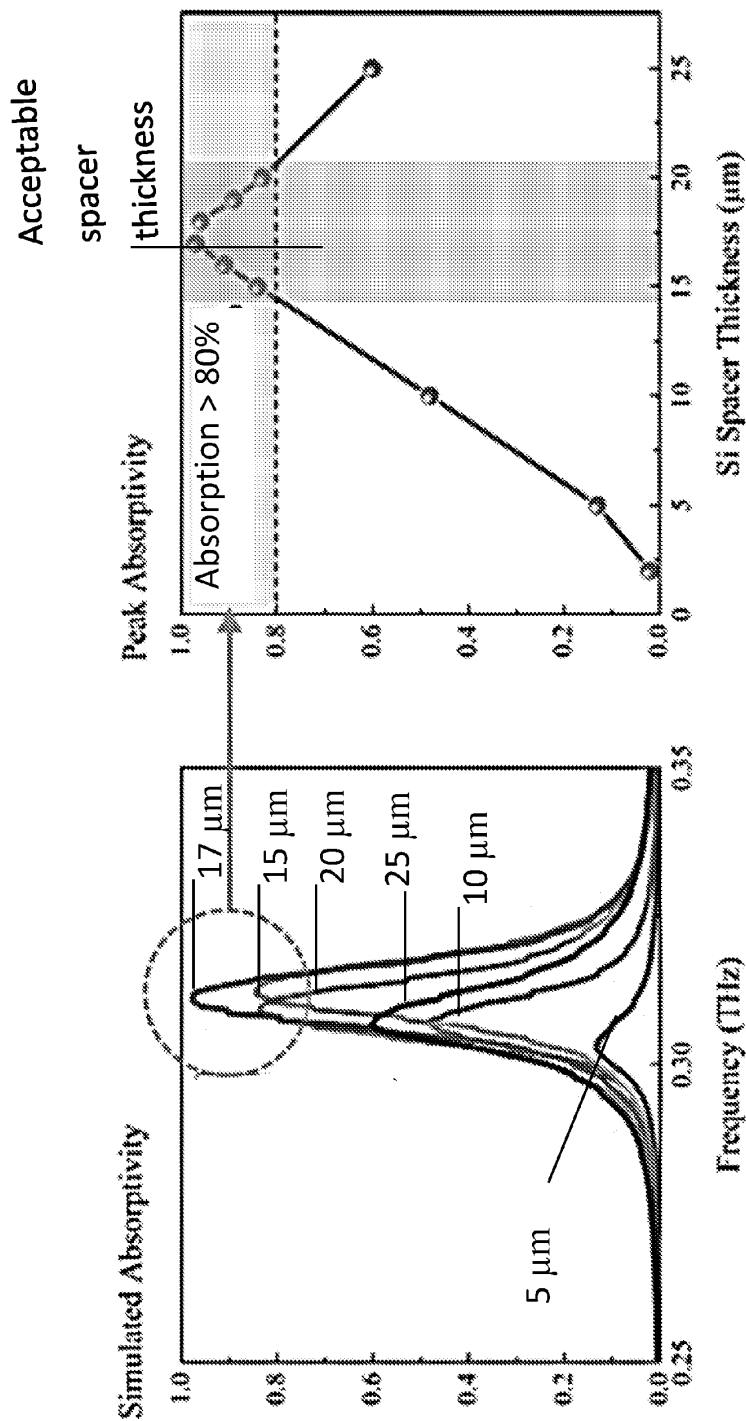


FIG. 4B

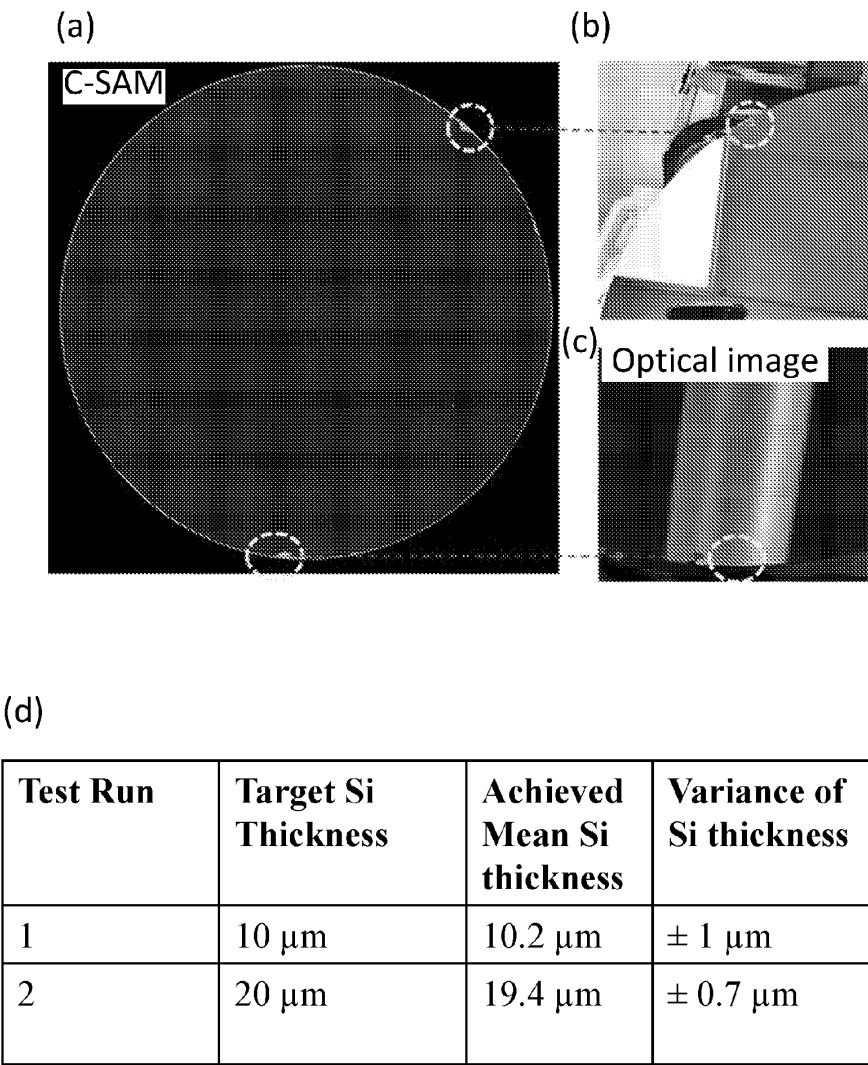


FIG. 4C

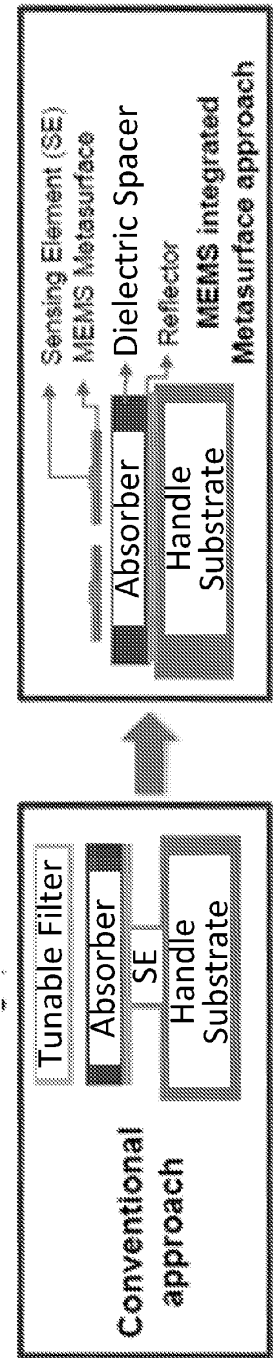
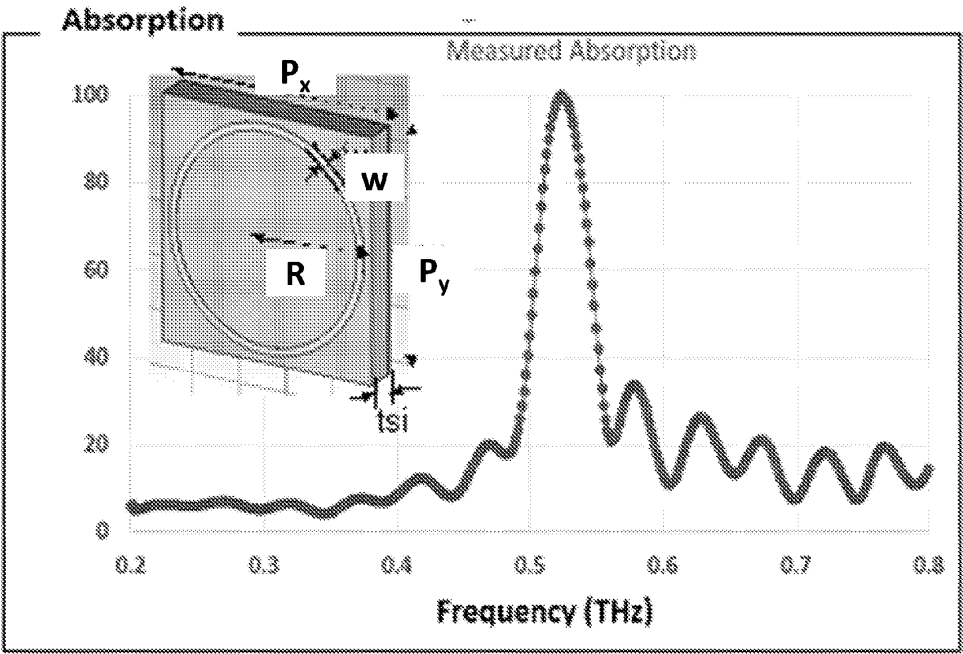


FIG. 4D



Parameters	CRR – Design 1	CRR – Design 2
Frequency (THz)	0.3	0.51
Wavelength (μm)	1000	590
Pitch P_x (μm)	120 ($\sim\lambda/8$)	120 ($\sim\lambda/5$)
Pitch P_y (μm)	120	120
Width of ring w (μm)	6	6
Radius of ring R (μm)	55	36
Reflector layer thickness T_g (μm)	1	1
Metasurface thickness T_m (μm)	0.2	0.2
Silicon spacer thickness T_{Si} (μm)	13 ($\sim\lambda/76$)	13 ($\sim\lambda/45$)
Refractive index of silicon n_{Si}	3.4	3.4
Optical spacer thickness (μm)	45 ($\sim\lambda/22$)	45 ($\sim\lambda/13$)

FIG. 5

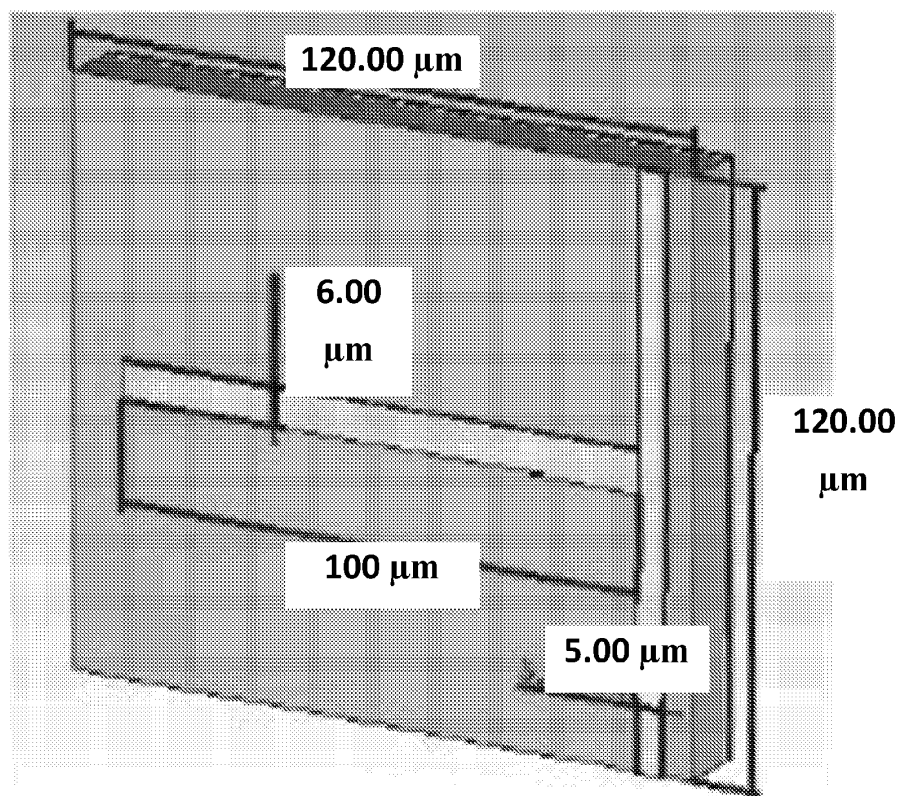


FIG. 6A

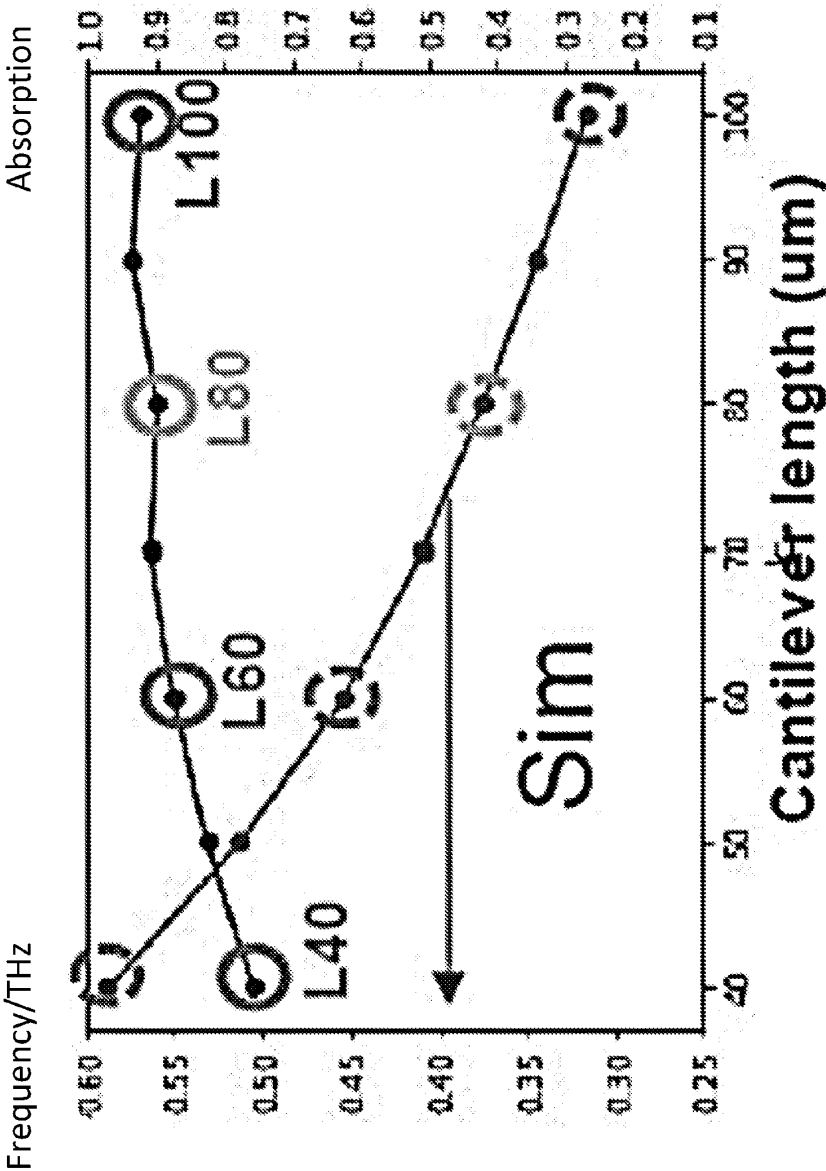


FIG. 6B

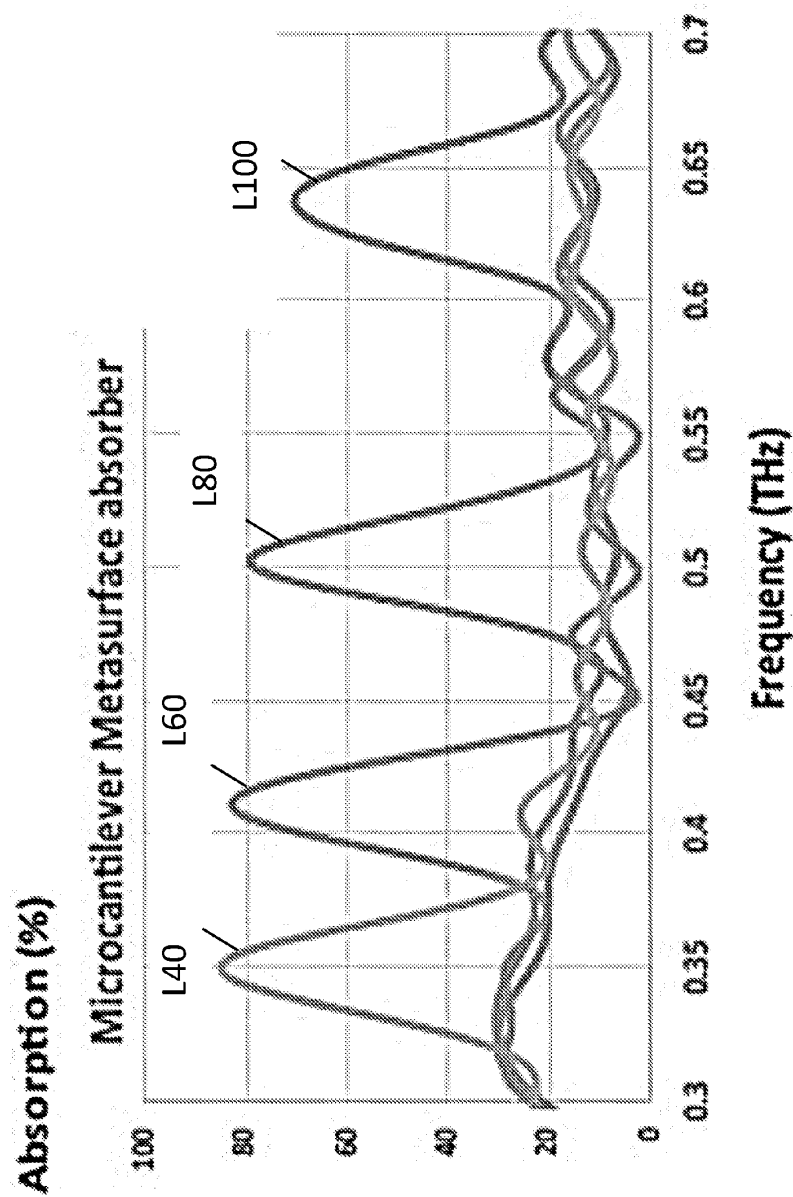


FIG. 6C

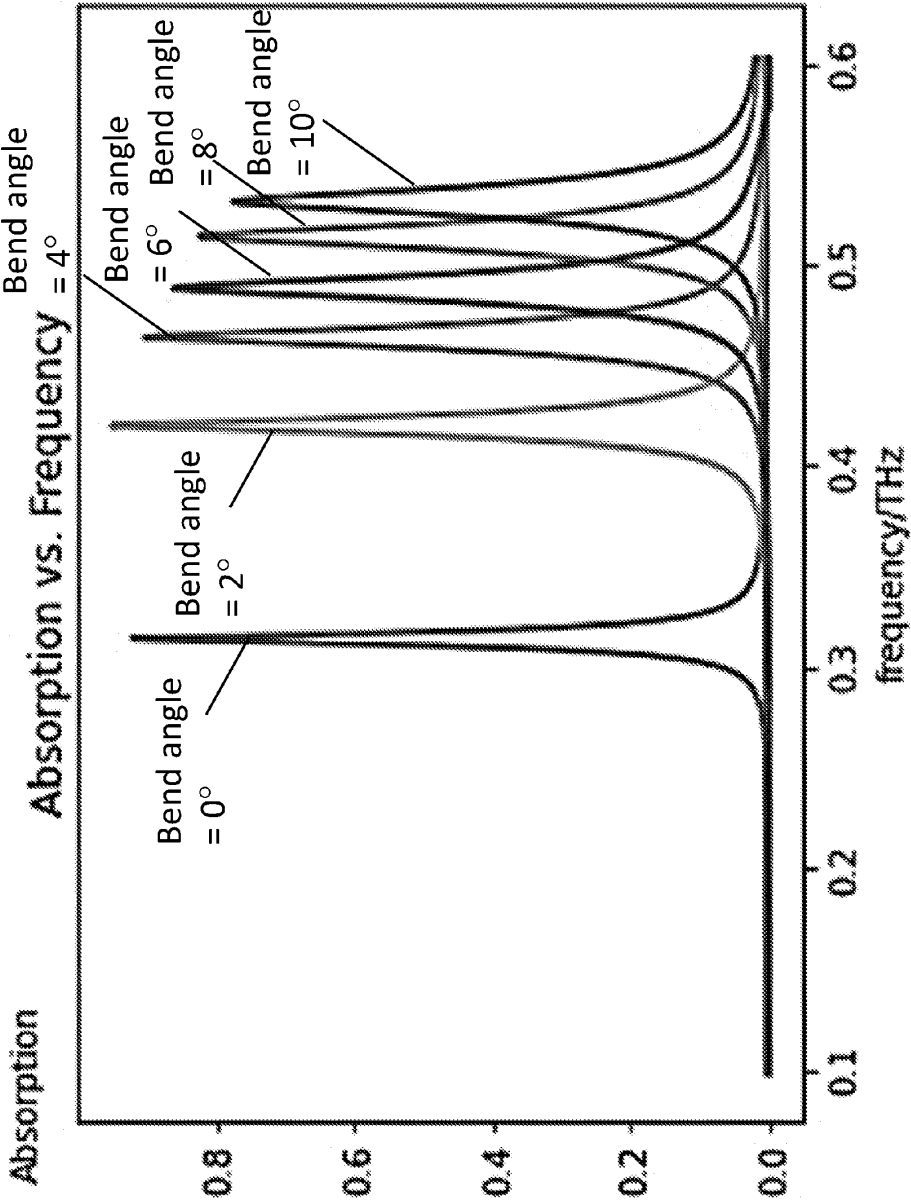


FIG. 7A

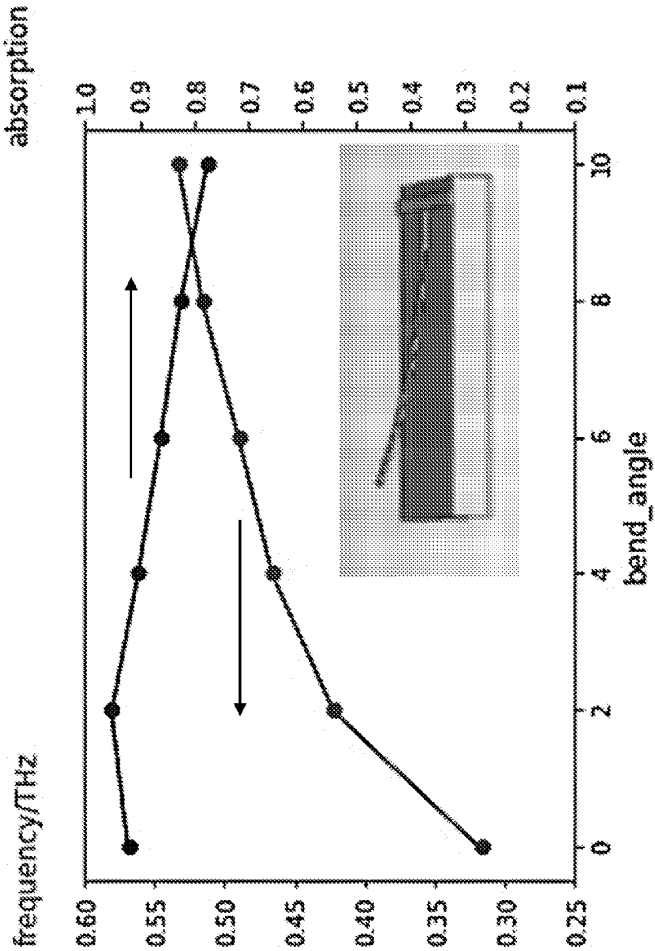


FIG. 7B

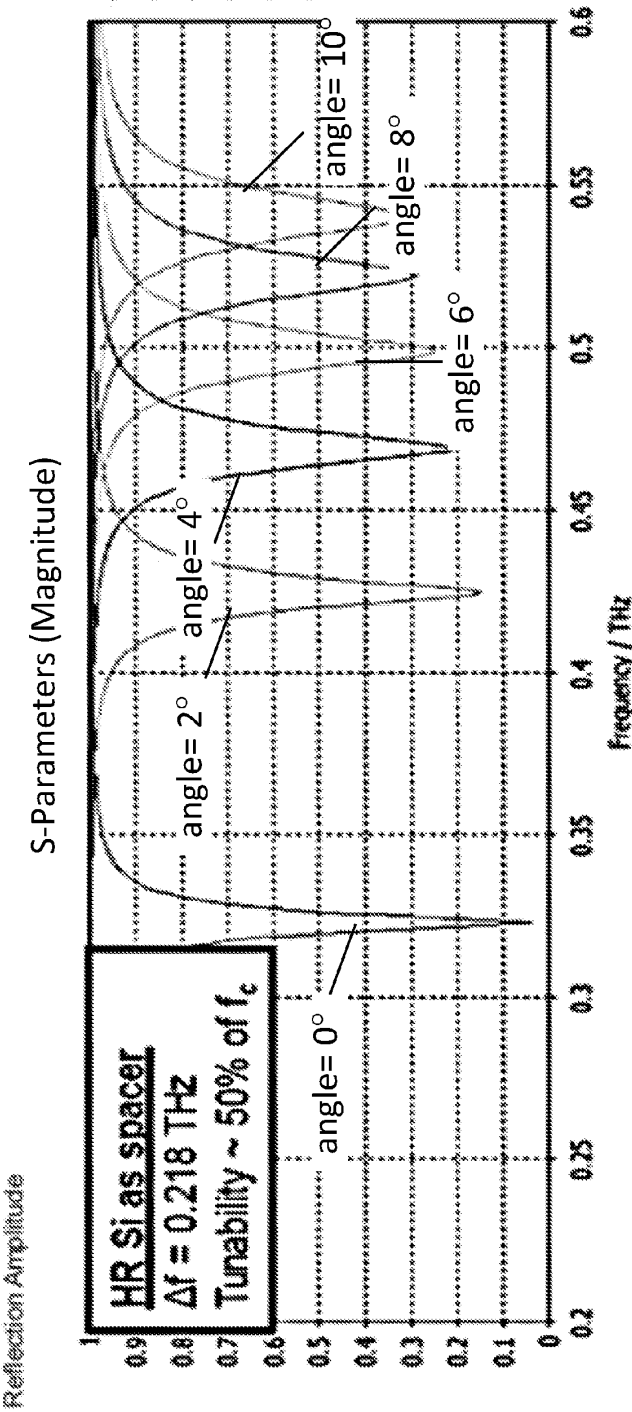


FIG. 8A

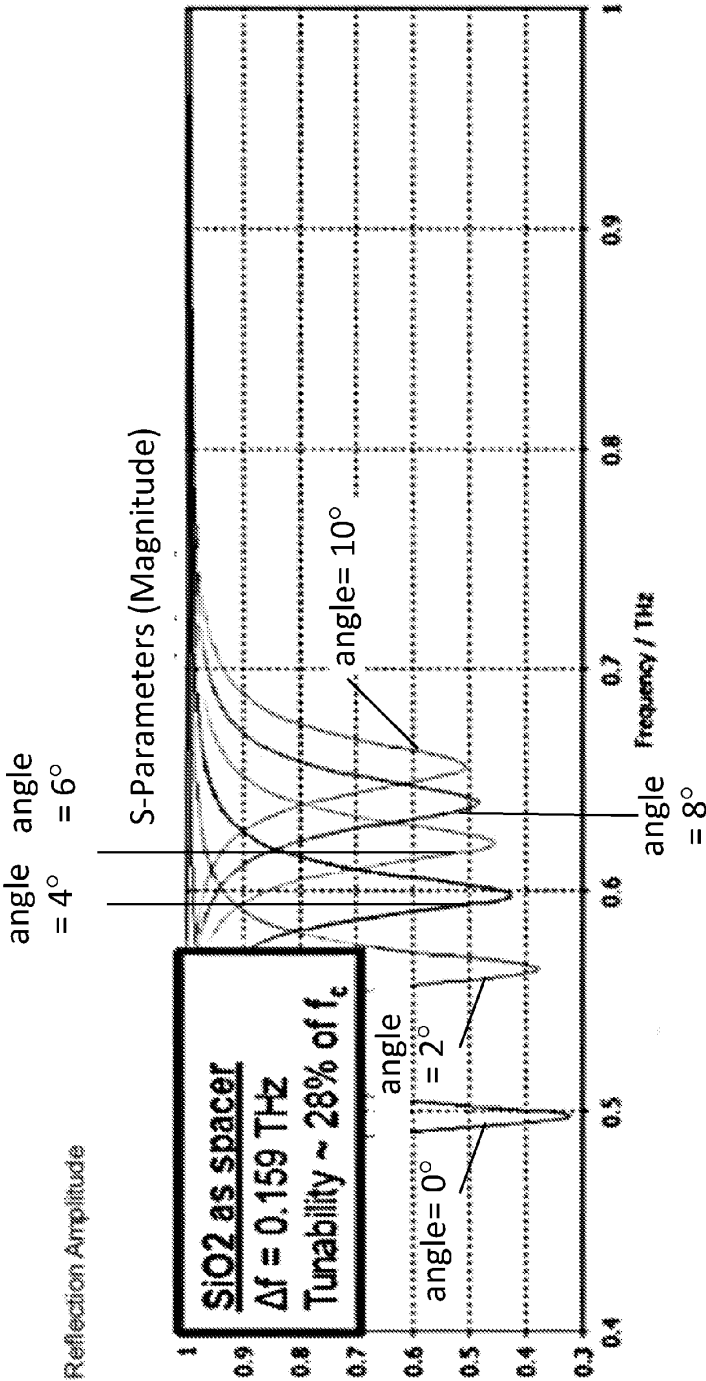


FIG. 8B

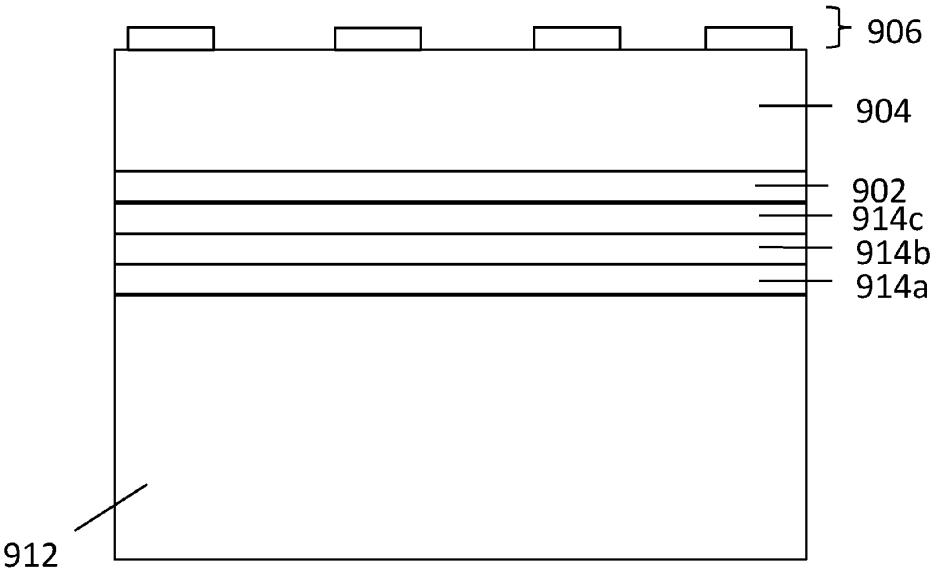


FIG. 9A

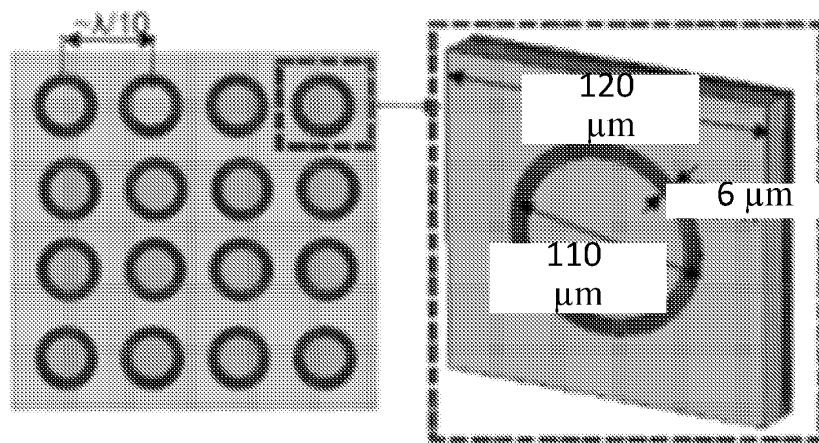


FIG. 9B

Reference No.	Name	Example Thickness And Material	General Requirement
912	Handle substrate	775 μm Test Si	Any material with mechanical stability
914a	Bonding interface layer	TiSi	Formed during bonding process
914b	Bonding material layer	300 nm Ti	Any suitable material
914c	Diffusion barrier layer	20 nm TiN	An suitable barrier layer to prevent bonding material diffusion
902	Reflector layer	1 μm Al	Any metal (Al, Mo, Ti, or Cu) or highly electrically conductive layer
904	Dielectric spacer	17 μm HR Si	Any dielectric or combination of dielectric with sub- λ optical thickness (refractive index $\times$ thickness)
906	Metasurface	1 μm Al	Any metal (Al, Mo, Ti, or Cu) or highly electrically conductive layer. Lateral pitch in sub-wavelengths.

FIG. 9C

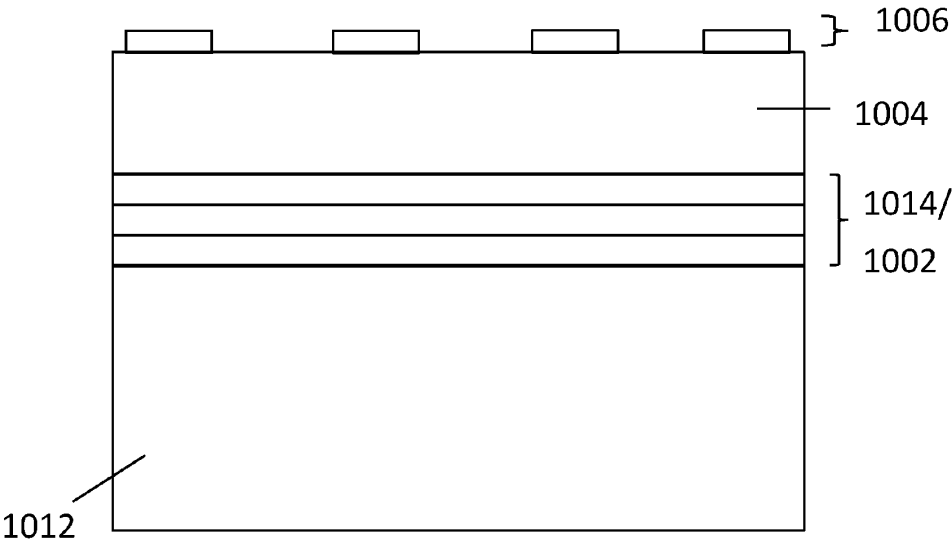


FIG. 10A

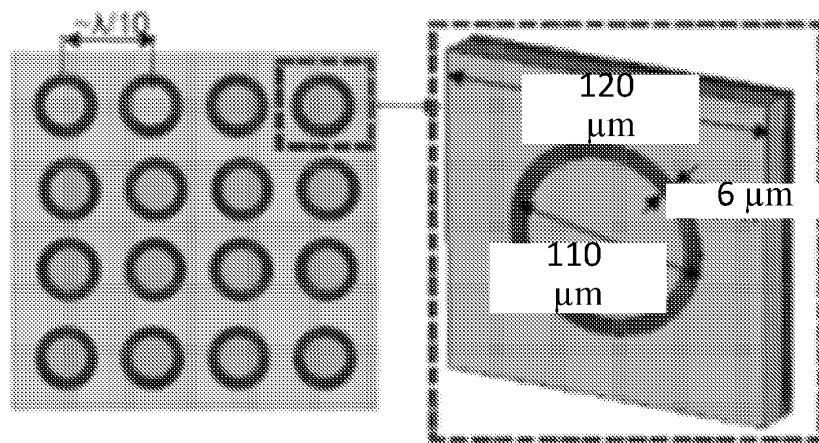


FIG. 10B

Reference No.	Name	Example Thickness And Material	General Requirement
1012	Handle substrate	775 μm Test Si	Any material with mechanical stability
1014/1002	Bonding stack (may act as a reflector layer or includes a reflector layer)	200 nm Ti	Includes a metallic/electrically conductive layer which functions as a bonding layer and a reflector layer
1004	Dielectric spacer	17 μm HR Si	Any dielectric or combination of dielectric with sub- λ optical thickness (refractive index $\times$ thickness)
1006	Metasurface	1 μm Al	Any metal (Al, Mo, Ti, or Cu) or highly electrically conductive layer. Lateral pitch in sub-wavelengths.

FIG. 10C

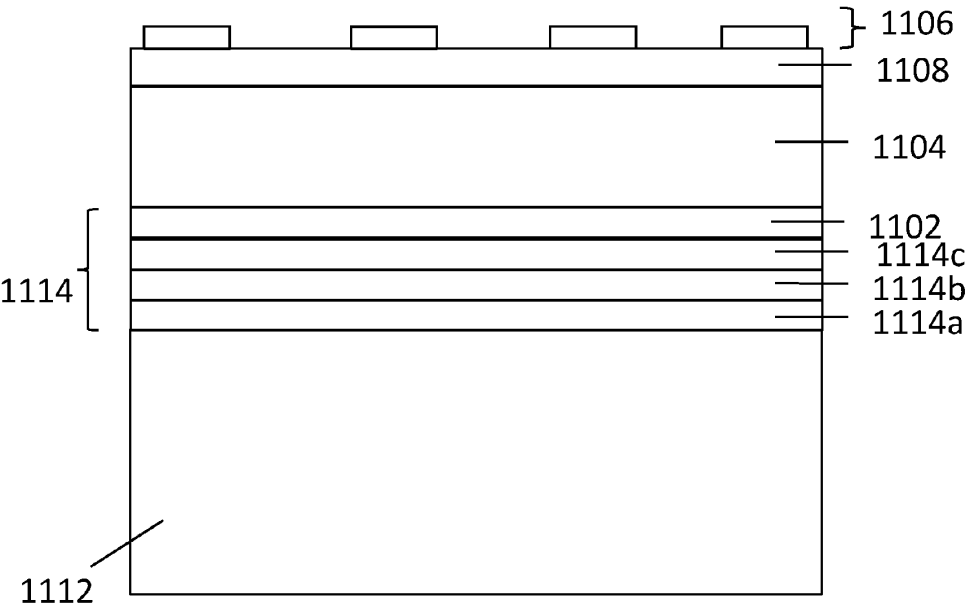


FIG. 11

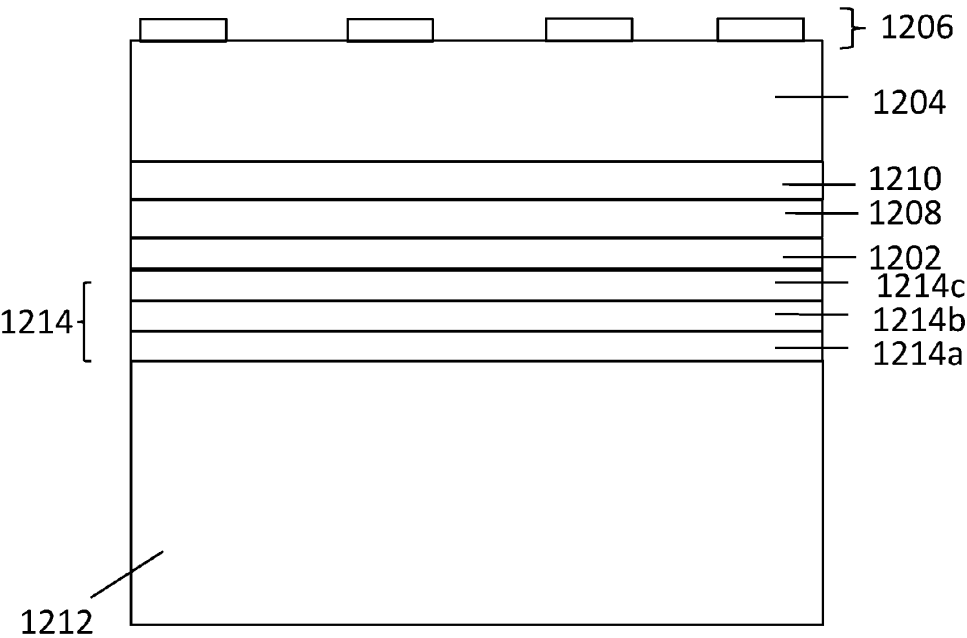


FIG. 12

Reference No.	Name	Example Thickness And Material	General Requirement
1112, 1212	Handle substrate	775 μm Test Si	Any material with mechanical stability
1114a, 1214a	Bonding interface layer	TiSi	Formed during bonding process
1114b, 1214b	Bonding material layer	200 nm Ti	Any suitable material
1114c, 1114c	Diffusion barrier layer	20 nm TiN	An suitable barrier layer to prevent bonding material diffusion
1102, 1210	Reflector layer	1 μm Al	Any metal (Al, Mo, Ti, or Cu) or highly electrically conductive layer
1104, 1204	Dielectric spacer	17 μm HR Si	Any dielectric or combination of dielectric with sub- λ optical thickness (refractive index $\times$ thickness)
1106, 1206	Metasurface	1 μm Al	Any metal (Al, Mo, Ti, or Cu) or highly electrically conductive layer. Lateral pitch in sub-wavelengths.
1108, 1208	Sensing layer	a-Si, VO_x , AlN, ScAlN	Any TCR or pyroelectric material for sensing the temperature change

FIG. 13

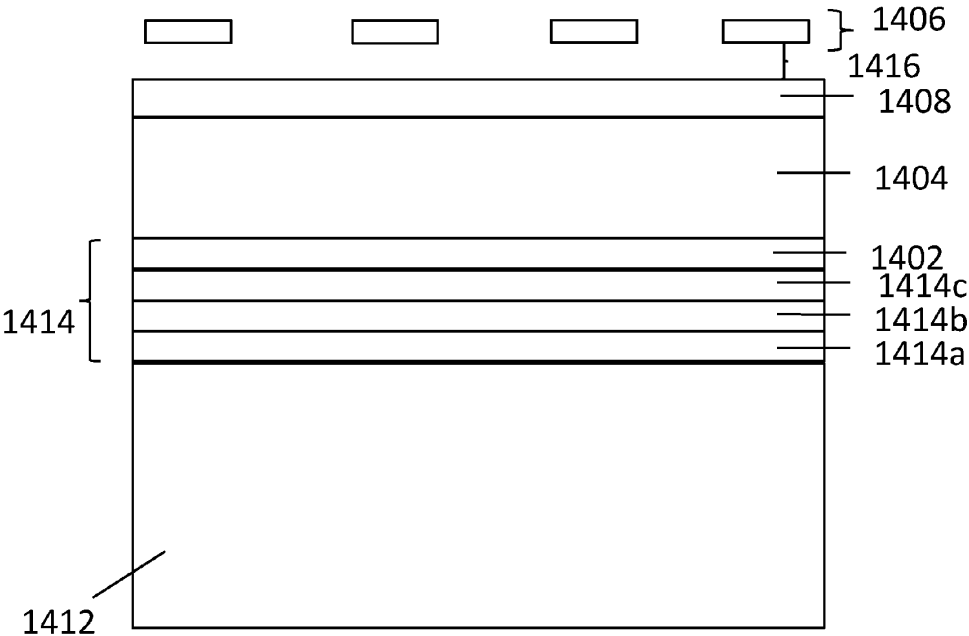


FIG. 14

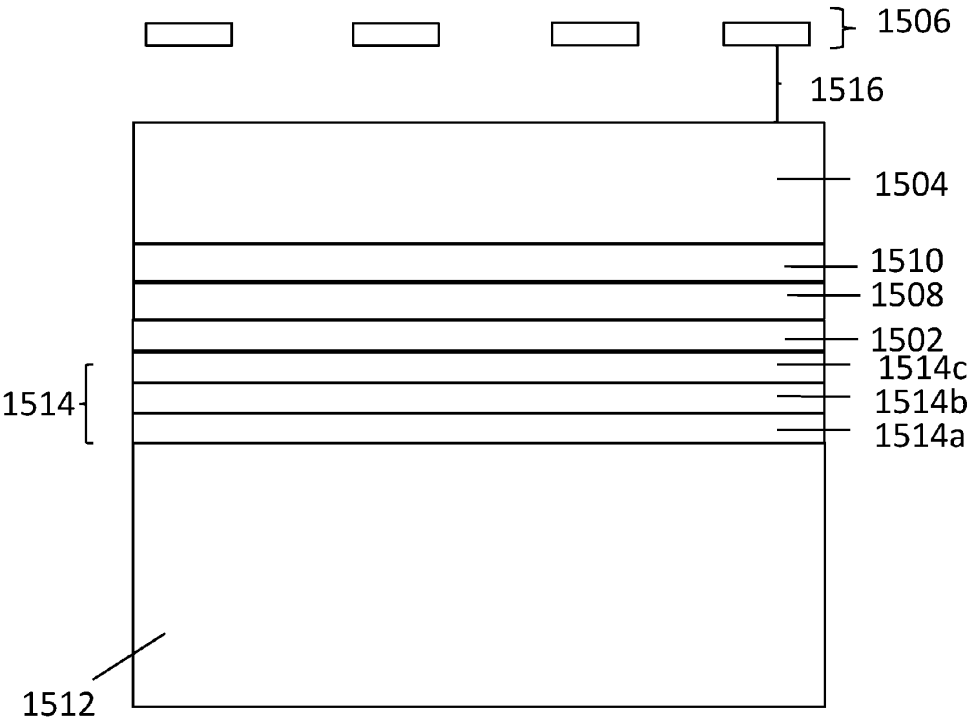


FIG. 15

Reference No.	Name	Example Thickness And Material	General Requirement
1412, 1512	Handle substrate	775 μm Test Si	Any material with mechanical stability
1414a, 1514a	Bonding interface layer	TiSi	Formed during bonding process
1414b, 1514b	Bonding material layer	200 nm Ti	Any suitable material
1414c, 1514c	Diffusion barrier layer	20 nm TiN	An suitable barrier layer to prevent bonding material diffusion
1402, 1510	Reflector layer	1 μm Al	Any metal (Al, Mo, Ti, or Cu) or highly electrically conductive layer
1404, 1504	Dielectric spacer	17 μm HR Si	Any dielectric or combination of dielectric with sub- λ optical thickness (refractive index $\times$ thickness)
1406, 1506	Metasurface	1 μm Al	Any metal (Al, Mo, Ti, or Cu) or highly electrically conductive layer. Lateral pitch in sub-wavelengths.
1408, 1508	Sensing layer	a-Si, VO_x , AlN, ScAlN	Any TCR or pyroelectric material for sensing the temperature change
1416, 1516	Tunable gap for reconfigurability	Air	Airgap

FIG. 16

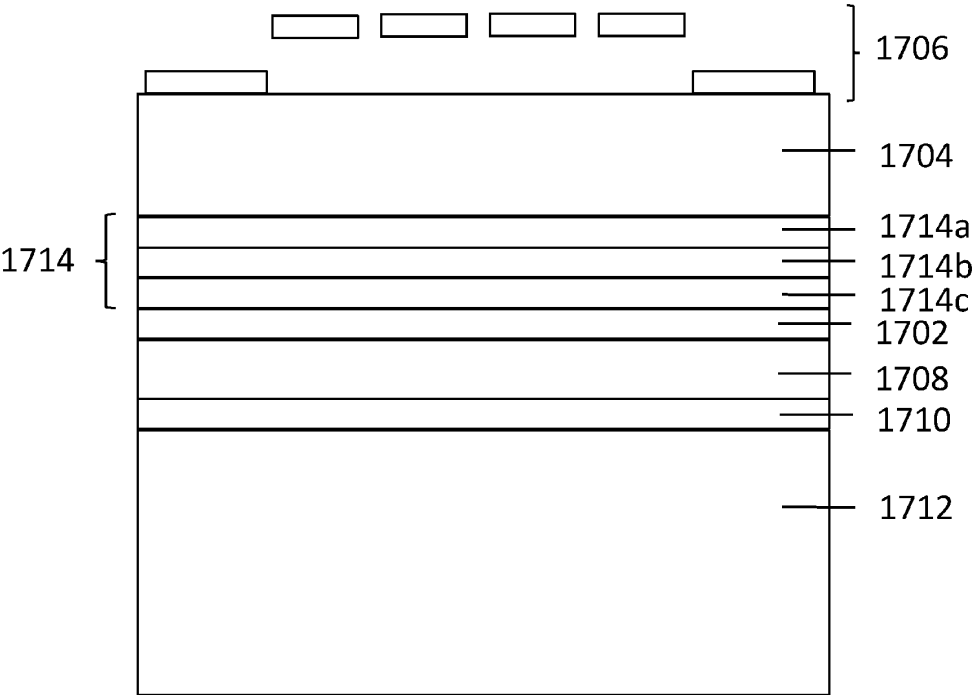


FIG. 17

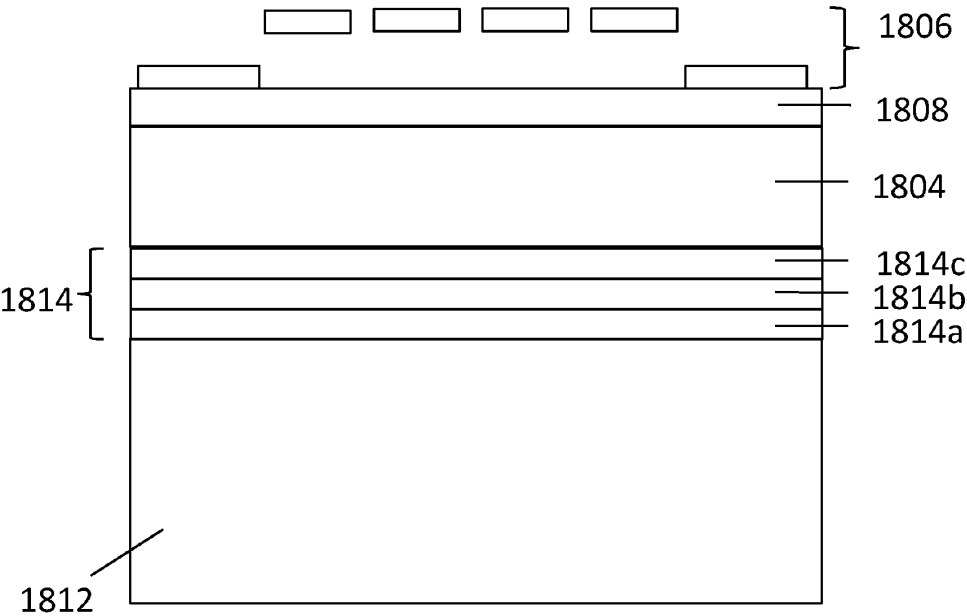


FIG. 18

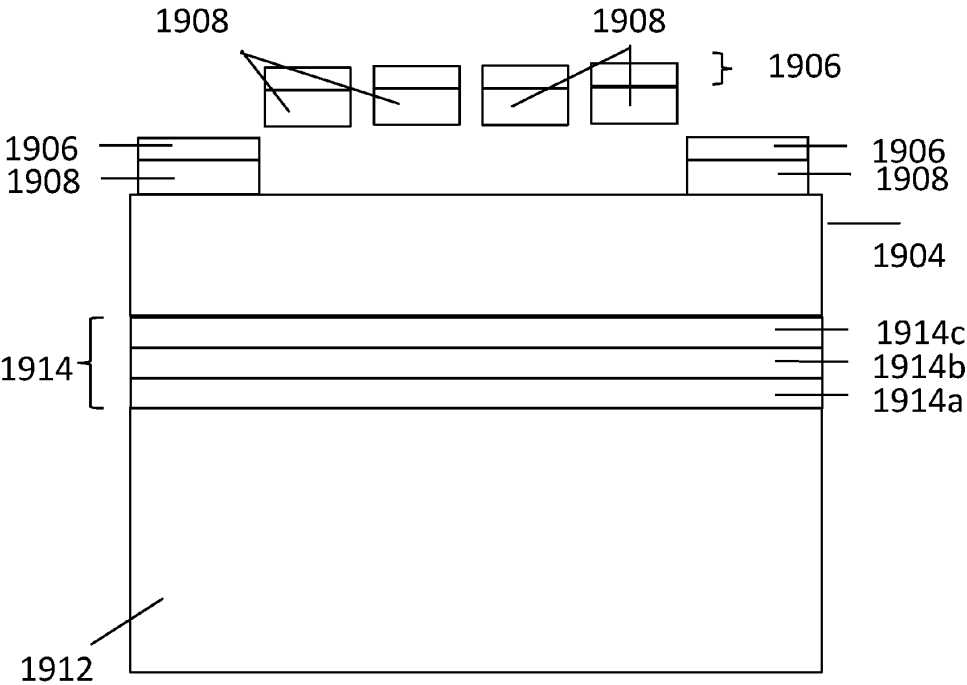


FIG. 19