CLAIMS

[Claim 1]

A sheet for forming a protective film, the sheet comprising a laminated structure of a curable resin film (x) and a support sheet (Y), wherein

the curable resin film (x) is a thermosetting resin film (x1) containing the polymer component (A) including poly(vinyl acetal)s, and containing thermosetting component including epoxy resin (B1), and wherein

the sheet for forming a protective film is to be used to form a protective film (X) on a bump-formed surface of a semiconductor wafer, the semiconductor wafer including a plurality of bumps and satisfying Requirements (α1) and (α2):

• Requirement (α1): A width (BM_W) (unit: μm) of the bump is from 20 μm to 350 μm; and

• Requirement (α2): A pitch (BM_P) (unit: μm) of the bumps and the width (BM_W) (unit: μm) of the bump satisfy Relationship (I):

$$[(BM_P)/(BM_W)] \leq 1.0 \qquad (I)$$; and

the sheet for forming a protective film satisfies Requirements (β1) to (β3):

• Requirement (β1): A modulus of elasticity in tension at 23°C, E' (23°C), of the protective film (X) formed by curing the curable resin film (x) is from 1×10^7 Pa to 1×10^{10} Pa;

• Requirement (β2): A modulus of elasticity in tension at 260°C, E' (260°C), of the protective film (X) formed by curing the curable resin film (x) is from 1×10^5 Pa to 1×10^8 Pa; and

• Requirement (β3): A thickness (X_T) (unit: μm) at 23°C of the protective film (X) formed by curing the curable resin film (x) and a height (BM_h) (unit: μm) of the bump satisfy Relationship (II):

$[(X_T)/(BM_h)] \geq 0.2$ (II).

[Claim 2]

A sheet for forming a protective film, the sheet comprising a laminated structure of a curable resin film (x) and a support sheet (Y), wherein

the sheet for forming a protective film is to be used to form a protective film (X) on a bump-formed surface of a semiconductor wafer, the semiconductor wafer including a plurality of bumps and satisfying Requirements (α1) and (α2):

• Requirement (α1): A width (BM_w) (unit: μm) of the bump is from 20 μm to 350 μm; and

• Requirement (α2): A pitch (BM_P) (unit: μm) of the bumps and the width (BM_w) (unit: μm) of the bump satisfy Relationship (I):

$[(BM_P)/(BM_w)] \leq 0.70$ (I); and

the sheet for forming a protective film satisfies Requirements (β1) to (β3):

• Requirement (β1): A modulus of elasticity in tension at 23°C, E' (23°C), of the protective film (X) formed by curing the curable resin film (x) is from 1×10^7 Pa to 1×10^{10} Pa;

• Requirement (β2): A modulus of elasticity in tension at 260°C, E' (260°C), of the protective film (X) formed by curing the curable resin film (x) is from 1×10^5 Pa to 1×10^8 Pa; and

• Requirement (β3): A thickness (X_T) (unit: μm) at 23°C of the protective film (X) formed by curing the curable resin film (x) and a height (BM_h) (unit: μm) of the bump satisfy Relationship (II):

$[(X_T)/(BM_h)] \geq 0.2$ (II).

[Claim 3]

The sheet for forming a protective film according to claim 1 or 2, the sheet further satisfying Requirement (α3b):

• Requirement (α3b): The height (BM_h) of the bump and the width (BM_w) of the bump satisfy Relationship (IIIb):

$$0.5 \leq [(BM_h)/(BM_w)] \leq 5.0 \qquad \text{(IIIb)}.$$

[Claim 4]

The sheet for forming a protective film according to any one of claims 1 to 3, the sheet further satisfying Requirement (α4):

• Requirement (α4): The height (BM_h) of the bump is from 15 μm to 300 μm.

[Claim 5]

The sheet for forming a protective film according to any one of claims 1 to 4, wherein the support sheet (Y) is a back grinding tape.

[Claim 6]

A method of manufacturing a semiconductor wafer with a protective film, the method comprising:

(S1) preparing a semiconductor wafer including a bump-formed surface provided with a plurality of bumps;

(S2) bonding the sheet for forming a protective film described in any one of claims 1 to 5 to the bump-formed surface of the semiconductor wafer with pressing the sheet to the bump-formed surface of the semiconductor wafer, using the curable resin film (x) as a bonding surface; and

(S3) curing the curable resin film (x) to form the protective film (X), wherein

the curable resin film (x) is a thermosetting resin film (x1) containing the polymer component (A) including poly(vinyl acetal)s, and containing thermosetting component including epoxy resin (B1) ,

and wherein the semiconductor wafer prepared in the step (S1) satisfies Requirements (α1) and (α2):

• Requirement (α1): The width (BM_W) (unit: μm) of the bump is from 20 μm to 350 μm; and

• Requirement (α2): The pitch (BM_P) (unit: μm) of the bumps and the width (BM_W) (unit: μm) of the bump satisfy Relationship (I):

$$[(BM_P)/(BM_W)] \leq 1.0 \qquad (I).$$

[Claim 7]

A method of manufacturing a semiconductor wafer with a protective film, the method comprising:

(S1) preparing a semiconductor wafer including a bump-formed surface provided with a plurality of bumps;

(S2) bonding the sheet for forming a protective film described in any one of claims 1 to 5 to the bump-formed surface of the semiconductor wafer with pressing the sheet to the bump-formed surface of the semiconductor wafer, using the curable resin film (x) as a bonding surface; and

(S3) curing the curable resin film (x) to form the protective film (X),

wherein the semiconductor wafer prepared in the step (S1) satisfies Requirements (α1) and (α2):

• Requirement (α1): The width (BM_W) (unit: μm) of the bump is from 20 μm to 350 μm; and

• Requirement (α2): The pitch (BM_P) (unit: μm) of the bumps and the width (BM_W) (unit: μm) of the bump satisfy Relationship (I):

$$[(BM_P)/(BM_W)] \leq 0.70 \qquad (I).$$

[Claim 8]

A method of manufacturing a semiconductor chip with a protective film, the method comprising:

(T1) performing the manufacturing method described in claim 6 or 7 to produce a semiconductor wafer with a protective film; and

(T2) dividing the semiconductor wafer with a protective film into individual pieces.

[Claim 9]

A method of manufacturing a semiconductor package, the method comprising:

(U1) performing the manufacturing method described in claim 8 to produce a semiconductor chip with a protective film; and

(U2) electrically connecting a wiring board and the semiconductor chip with a protective film via the bumps.

[Claim 10]

The method of manufacturing a semiconductor package according to claim 9, the method further comprising:

(U3) filling an underfill material between the wiring board and the semiconductor chip with a protective film.