CLAIMS

1. A method of producing an encapsulated light emitting device, the method comprising:

providing a plurality of non-encapsulated light emitting elements mounted on a support structure;

providing a mold having a plurality of cavities that define a shape of an encapsulant to be formed around the light emitting element;

providing a release film covering the cavities, the release film comprising a fully fluorinated polymer;

conforming the release film to the interior of the cavities;

introducing a potting material into the space within the cavities, the release film preventing the potting material from contacting the interior of the cavities;

positioning the non-encapsulated light emitting elements so that they are within the cavities and surrounded by the potting material;

curing the potting material in the space between the light emitting elements and the release film in the cavities to encapsulate the light emitting elements; and

freeing the encapsulated light emitting elements from the mold and the release film.

2. A method of manufacturing a light emitting device including a light emitting element encapsulated by a resin lens, the method comprising:

providing a light emitting element mounted on a support structure;

providing a mold having a cavity that defines a shape of a lens to be formed around the light emitting element;

providing a release film covering the cavity, the release film comprising a perfluoroalkoxy polymer or fluorinated ethylene propylene;

conforming the release film to the interior of the cavity;

introducing a resin into the space within the cavity, the release film preventing the resin from contacting the interior of the cavity;

positioning the light emitting element so that it is within the cavity and surrounded by the resin;

curing the resin in the space between the light emitting element and the release film in the cavity to form a lens encapsulating the light emitting element; and

freeing the light emitting device from the mold and the release film.

3. An apparatus for manufacturing a light emitting device, the apparatus comprising:

a mold having a plurality of cavities that define a lens shape;

winding reels for scrolling a mold release film over the plurality of cavities;

a dispenser for introducing a silicone resin into the plurality of cavities;

a vacuum system for applying a vacuum to the plurality of cavities to form the release film to the interior of the cavities; and

a supply of a mold release film, the mold release film comprising a roll of a fully fluorinated polymer film.

4. A method of producing an encapsulated light emitting device, the method comprising:

providing a plurality of non-encapsulated light emitting elements mounted on a support structure;

providing a mold having a plurality of cavities that define a shape of an encapsulant to be formed from a heat-curable resin around the light emitting element;

providing a release film covering the cavities, the release film selected from a group of fluorinated polymers having an elastic modulus of 50 MPa or less at 150°C, a glass transition temperature that is below the curing temperature of the heat-curable resin, a contact angle with water of at least 95 degrees, and a surface energy that is less than 25 dynes/cm;

conforming the release film to the interior of the cavities;

introducing a heat-curable resin into the space within the cavities, the release film preventing the potting material from contacting the interior of the cavities;

positioning the non-encapsulated light emitting elements so that they are within the cavities and surrounded by the heat-curable resin;

curing the heat-curable resin in the space between the light emitting elements and the release film in the cavities by heating the mold to the curing temperature of the resin; and

freeing the encapsulated light emitting elements from the mold and the release film.

5. The method of any of the preceding claims in which the light emitting device comprises a light emitting diode (LED), a visible light LED, a through-hole LED, a surface mount LED, a high-brightness LED, or an organic LED.

6. The method of any of the preceding claims in which the resin or potting material comprises an epoxy or silicone.

7. The method of any of the preceding claims in which conforming the release film to the interior of the cavities comprises applying a vacuum to the cavities through a vacuum port to fit the release film to the interior of the cavities.

8. The method of any of the preceding claims in which the fluorinated polymer comprises a perfluoroalkoxy polymer formed from polymerization of at least tetrafluoroethylene (TFE) and perfluoromethyl vinyl ether (PMVE).

9. The method of any of the preceding claims in which the fluorinated polymer comprises perfluoro methyl alkoxy (MFA).

10. The method of any of the preceding claims in which the fluorinated polymer comprises fluorinated ethylene propylene (FEP).

11. The method of any of the preceding claims in which the fluorinated polymer has a contact angle with water of at least 93 degrees.

12. The method of any of the preceding claims in which the fluorinated polymer has a contact angle with water of at least 95 degrees.

13. The method of any of the preceding claims in which the fluorinated polymer has an elastic modulus at 150°C of no more than 50MPa.

14. The method of any of the preceding claims in which the fluorinated polymer has an elastic modulus at 150°C of no more than 35 MPa.

15. The method of any of the preceding claims in which the fluorinated polymer has an elastic modulus at 150°C of no more than 30 MPa.

16. The method of any of the preceding claims in which the fluorinated polymer has an elastic modulus at 150°C of no more than 25 MPa.

17. The method of any of the preceding claims in which the fluorinated polymer has a glass transition temperature of less than 100°C.

18. The method of any of the preceding claims in which the fluorinated polymer has a glass transition temperature of less than 90°C.

19. The method of any of the preceding claims in which the fluorinated polymer has a surface energy that is less than 25 dynes/cm.

20. The method of any of the preceding claims in which the fluorinated polymer has a surface energy that is less than 20 dynes/cm.

21. The method of any of the preceding claims in which the release film comprising a fluorinated polymer has an average surface roughness of 0.20 μm or less.

22. The method of any of the preceding claims in which the release film comprising a fully fluorinated polymer has an average surface roughness of 0.15 μm or less.

23. The method of any of the preceding claims in which the release film comprising a fluorinated polymer has an average surface roughness of 0.10 μm or less.

24. A light emitting device made by the method of any of the preceding claims.

25. A mold release film for use in manufacturing a light emitting device, the release film comprising a roll of fully fluorinated polymer film, the fully fluorinated polymer having a melting temperature of greater than 200°C, a tensile strength of 20 MPa or greater, and an elongation-at-break at 150°C of greater than 300%.

26. The release film of claim 25 in which the fully fluorinated polymer has an elastic modulus at 150°C of no more than 50MPa.

27. The release film of claim 25 in which the fully fluorinated polymer has an elastic modulus at 150°C of no more than 35 MPa.

28. The release film of claim 25 in which the fully fluorinated polymer has an elastic modulus at 150°C of no more than 30 MPa.

29. The release film of claim 25 in which the fully fluorinated polymer has an elastic modulus at 150°C of no more than 25 MPa.

30. The method of any of claims 25 to 29 in which the fully fluorinated polymer has a glass transition temperature of less than 100°C.

31. The method of any of claims 25 to 29 in which the fully fluorinated polymer has a glass transition temperature of less than 90°C.

32. The method of any of claims 25 to 31 in which the release film comprising a fully fluorinated polymer has an average surface roughness of 0.20 μm or less.

33. The method of any of claims 25 to 31 in which the release film comprising a fully fluorinated polymer has an average surface roughness of 0.15 μm or less.

34. The method of any of claims 25 to 31 in which the release film comprising a fully fluorinated polymer has an average surface roughness of 0.10 μm or less.

35. The method of any of claims 25 to 32 in which the fully fluorinated polymer has a surface energy that is less than 25 dynes/cm.

36. The method of any of claims 25 to 32 in which the fully fluorinated polymer has a surface energy that is less than 20 dynes/cm.

37. The method of any of claims 25 to 36 in which the fully fluorinated polymer comprises MFA or FEP.

38. A mold release film for use in molding a silicon lens to encapsulate a light emitting diode, the mold release film comprising a fluorinated polymer film having a glass transition temperature of less than 100°C; an elastic modulus at 150°C of no more than 50MPa; and an average surface roughness of 0.20 μm or less.

39. The mold release film of claim 38 in which the fluorinated polymer film has a glass transition temperature of less than 90°C.

40. The mold release film of any of claims 25 to 39 in which the fluorinated polymer film has an elastic modulus at 150°C of no more than 35 MPa.

41. The mold release film of any of claims 25 to 39 in which the fluorinated polymer film has an elastic modulus at 150°C of no more than 30 MPa.

42. The mold release film of any of claims 25 to 39 in which the fluorinated polymer film has an elastic modulus at 150°C of no more than 25 MPa.

43. The mold release film of any of claims 25 to 42 in which the fluorinated polymer film has an average surface roughness of 0.15 μm or less.

44. The mold release film of any of claims 25 to 42 in which the fluorinated polymer film has an average surface roughness of 0.10 μm or less.

45. The mold release film of any of claims 25 to 44 in which the fluorinated polymer film comprises a fully fluorinated thermoplastic polymer film.

46. The mold release film of any of the preceding claims in which the release film has a thickness of no more than 3 mils.

47. The mold release film of any of claims 25 to 46 in which the fluorinated polymer film has a contact angle with water of at least 93 degrees, or of at least 95 degrees.

48. The mold release film of any of claims 25 to 47 in which the fluorinated polymer film comprises a perfluoroalkoxy polymer formed from polymerization of at least tetrafluoroethylene (TFE) and perfluoromethyl vinyl ether (PMVE).

49. The mold release film of any of claims 25 to 47 in which the fluorinated polymer film comprises perfluoro methyl alkoxy (MFA).

50. The mold release film of any of claims 25 to 47 in which the fluorinated polymer film comprises fluorinated ethylene propylene (FEP).

CLAIMS

1. An invention not claimed in any divisional application.