What is claimed is:

1. A sensor for detecting surface defects in an object, the sensor comprising:

a leaky-wave antenna comprising an array of unit cells wherein each unit cell comprises:

a slotted patch antenna overlaying a slotted substrate integrated waveguide (SIW);

a millimetre-wave transceiver; and

a circulator communicably coupled between the leaky-wave antenna and the millimetre-wave transceiver for controlling transmission and reception of millimetre-wave there between.

2. The sensor of claim 1, wherein the circulator comprises a planar magic tee which comprises an E-plane overlaying a H-plane,

wherein the H-plane comprises:

a first SIW which comprises two collinear ports and a side port defining a T-junction, wherein each of the three ports comprises a microstrip-to-SIW transition, wherein the first SIW is formed with a first slot; and

a first via fence disposed along edges of the first SIW, which are outside the microstrip-to-SIW transitions of the three ports;

wherein the E-plane comprises:

a second SIW which comprises a single port comprising a microstrip-to-SIW transition, wherein a second slot is formed in the second SIW and disposed in fluid communication with the first slot; and

a second via fence disposed at locations of the second SIW, which are outside the microstrip-to-SIW transition of the single port, wherein the second via fence defines an enclosure wall extending towards one of the collinear ports and two walls forming an open end directed towards the single port.

3. The sensor of claim 2, wherein the first slot is arranged along a line of symmetry between the collinear ports.

4. The sensor of any one of claims 2 to 3, wherein the H-plane further comprises:

a first tuning via disposed at the first SIW along a line of symmetry between the collinear ports.

5. The sensor of claim 4, wherein the first tuning via is located along the line of symmetry and closer to one of the edges which is most distal from the side port.

6. The sensor of any one of claims 2 to 5, wherein the E-plane further comprises:

a second tuning via disposed at the second SIW at a location which is between the two walls forming the open end and is closer to a shorter one of the two walls.

7. The sensor of claim 6, wherein the second tuning via is located closer to the shorter one of the two walls in a direction parallel to an axis through the collinear ports.

8. The sensor of any one of claims 1 to 7, wherein the slotted SIW comprises:

a lower dielectric layer interposed between two ground layers;

a via fence traversing the lower dielectric layer and shorted to the two ground layers;

wherein the slotted patch antenna comprises:

an upper dielectric layer; and

a radiating patch disposed on a top side of the upper dielectric layer,

wherein an upper one of the two ground layers is juxtaposed against a bottom side of the upper dielectric layer.

9. The sensor of claim 8, wherein a height of the lower dielectric layer greater than a height of the upper dielectric layer, wherein the lower and the upper dielectric layer have the same relative permittivity and dielectric loss.

10. The sensor of claim 1, wherein the array of unit cells forms a single row parasitic slotted-patch array.

11. An apparatus for detection of surface defect in an object, the apparatus comprising:

the sensor of any one of claims 1 to 10;

a memory for storing instructions;

a detector device for detecting millimetre-wave signals;

a processor communicably coupled to the memory, detector device and the sensor and configured to execute the instructions to:

control transmission, from the millimetre-wave transceiver, of millimetre waves at different frequencies to produce a scanning beam for back-fire to end-fire scanning of a surface of an object;

receive, from the detector device, signals of the millimetre waves reflected off the surface of the object;

generate an image of the received signals of the reflected millimetre-wave; and

determine presence of a defect from the generated image.

12. A method of fabricating a sensor device, the method comprising:

communicably coupling a leaky-wave antenna to a planar magic tee; and

communicably coupling a millimetre-wave transceiver to the planar magic tee such that the planar magic tee is communicably coupled between the leaky-wave antenna and the millimetre-wave transceiver.

13. The method of claim 12, further comprising:

fabricating the planar magic tee, comprising:

fabricating a first SIW which comprises two collinear ports and a side port defining a T-junction;

disposing a microstrip-to-SIW transition at each of the three ports;

forming a first slot in the first SIW;

disposing a first via fence along edges of the first SIW, which are outside the microstrip-to-SIW transitions of the three ports;

fabricating a second SIW which comprises a single port;

disposing a microstrip-to-SIW transition at the single port;

forming a second slot in the second SIW;

disposing a second via fence at locations of the second SIW, which are outside the microstrip-to-SIW transition of the single port, wherein the second via fence defines an enclosure wall extending towards one of the collinear ports and two walls forming an open end directed towards the single port; and

overlaying the second SIW on the first SIW such that the second slot is disposed in communication with the first slot.

14. The method of claim 13, further comprising:

disposing a first tuning via disposed at the first SIW along a line of symmetry between the collinear ports.

15. The method of claim 14, further comprising:

disposing a second tuning via at the second SIW at a location which is between the two walls forming the open end and is closer to a shorter one of the two walls.

16. The method of any one of claims 12 to 15, further comprising:

fabricating the leaky-wave antenna, comprising:

disposing a lower ground layer;

disposing a lower dielectric layer on or overlaying the lower ground layer;

disposing an upper ground layer on or overlaying the lower dielectric layer;

disposing an upper dielectric layer on or overlaying the upper ground layer;

disposing a radiating patch on or overlaying the upper dielectric layer;

forming at least one opening in the radiating patch.