CLAIMS

1. An airfoil for a gas turbine engine, comprising:

a pressure side; and

a suction side opposite the pressure side, the pressure side and the suction side extending axially from a leading edge to a trailing edge and radially from a base to a tip, the tip including a flat surface an oblique surface descending directly from the flat surface towards the pressure side at a clearance angle and a second oblique surface descending directly from the flat surface towards the suction side at a second clearance angle different from the clearance angle;

wherein a circumferential width of the flat surface varies along its length; and

wherein the flat surface extends only partially between the leading edge to the trailing edge, such that proximate the leading edge and the trailing edge, there is no flat surface; and

wherein the flat surface, the oblique surface and the second oblique surface include a hard plating reinforcement.

2. The airfoil of claim 1, wherein the circumferential width of the flat surface is at least 2.54 mm (0.1 in).

3. The airfoil of claim 1, wherein a clearance angle of the oblique surface is between zero to five degrees (0-5°).

4. A gas turbine engine, comprising:

a fan section;

a compressor section downstream of the fan section;

a combustor section downstream of the compressor section; and

a turbine section downstream of the combustor section, at least one of the fan section, compressor section, and the turbine section including:

a rotor,

a plurality of airfoils extending radially from the rotor, and

a fan case surrounding the rotor and the plurality of airfoils, each of the plurality of airfoils having a tip extending between a pressure side, a suction side, a leading edge, and a trailing edge, the tip including:

a flat surface facing the fan case, and

an oblique surface differently adjacent to the flat surface and extending toward the pressure side at an oblique angle, angled away from the fan case, and a second oblique surface directly adjacent to the flat surface and extending toward the suction side at a second oblique angle different from the oblique angle;

wherein a circumferential width of the flat surface varies along its length; and

wherein the flat surface extends only partially between the leading edge to the trailing edge, such that proximate the leading edge and the trailing edge, there is no flat surface; and

wherein the flat surface, the oblique surface and the second oblique surface include a hard plating reinforcement.

5. The gas turbine engine of claim 4, wherein the flat surfaces of the tips of the airfoils and the fan case are in sealing contact.

6. The gas turbine engine of claim 4, wherein the oblique surfaces and the second oblique surface of the tips of the airfoils reduce frictional heating between the airfoils and the fan case during operation.

7. The gas turbine engine of claim 4, wherein the fan case includes an abradable seal on an inner surface of the fan case.

8. The gas turbine engine of claim 7, wherein the flat surface, the oblique surface and the second oblique surface on the tip of each of the airfoils are designed to cut through the abradable seal of the fan case.

9. The gas turbine engine of claim 4, wherein the flat surface, the oblique surface and the second oblique surface of each of the tips of the airfoils undergo treatment for increased wear resistance.

10. A method for reducing frictional heating between airfoils and a casing of a gas turbine engine, the method comprising:

providing a flat surface on a tip of each of the airfoils, the flat surface in sealing contact with the casing;

providing an oblique surface on the tip of each of the airfoils, the oblique surface slanted away from the casing and descending directly from the flat surface towards a pressure side of the airfoil at a clearance angle;

providing a second oblique surface on the tip of each of the airfoils, the second oblique surface slanted away from the casing and descending directly from the flat surface towards a suction side of the airfoil opposite the pressure side at a second clearance angle different from the clearance angle; and

operating the gas turbine engine using the oblique surface and the second oblique surface;

wherein a circumferential width of the flat surface varies along its length; and

wherein the flat surface extends only partially between a leading edge to a trailing edge of the airfoil, such that proximate the leading edge and the trailing edge, there is no flat surface; and

wherein the flat surface, the oblique surface and the second oblique surface include a hard plating reinforcement.