CLAIMS

1. A catheter system comprising:

a catheter, the catheter comprising:

a catheter lumen comprising:

a proximal end;

a distal end;

an inner lumen surface; and

an outer lumen surface; and

a first electrode coupled to the catheter lumen and spaced apart from the distal end of the catheter; and

a second electrode coupled to the catheter lumen and spaced apart from the distal end of the catheter, wherein a distal end of the first electrode comprises a first portion that extends generally perpendicular to a proximal portion of the first electrode to form an L-shape, wherein a distal end of the second electrode comprises a second portion that extends generally perpendicular to a proximal portion of the second electrode to form another L-shape, wherein the first portion of the first electrode is spaced apart from and aligned with the second portion of the second electrode to create an electrode gap between the first portion of the first electrode and the second portion of the second electrode; and

a drug sensor in communication with the first and second electrodes coupled to the catheter lumen,

wherein when the distal end of the catheter lumen is inserted into a blood vessel of a patient:

at least a portion of the first and second electrodes are configured to be embedded within a soft tissue of the patient adjacent the blood vessel,

the first and second electrodes are configured to be in communication with each other through the soft tissue of the patient between the first and second electrodes, and

the drug sensor is configured to detect~~detects~~ whether extravasation of a drug has occurred from the blood vessel into the soft tissue of the patient by sensing a characteristic associated with the soft tissue of the patient, the characteristic comprising at least one of inductance, impedance, and capacitance.

2. The catheter system of claim 1, further comprising:

a catheter adapter coupled to the catheter, wherein the catheter adapter comprises an inner surface and an outer surface;

a first attachment feature configured to electrically couple the drug sensor to the first electrode; and

a second attachment feature configured to electrically couple the drug sensor to the second electrode, wherein the first attachment feature and the second attachment feature traverse between the inner surface of the catheter adapter and the outer surface of the catheter adapter.

3. The catheter system of claim 1, wherein:

the first electrode comprises an electrically conductive material deposited on the outer lumen surface; and

the second electrode comprises an electrically conductive material deposited on the outer lumen surface,

wherein the first and second electrodes are spaced apart from each other along the outer lumen surface.

~~4. The catheter system of claim 1, wherein:~~

~~the first electrode comprises an electrically conductive material placed within a first channel formed along the catheter lumen; and~~

~~the second electrode comprises an electrically conductive material placed within a second channel formed along the catheter lumen,~~

~~wherein the first and second electrodes are spaced apart from each other along the outer lumen surface.~~

~~5. The catheter system of claim 4, wherein:~~

~~the first and second channels comprise open channels; and~~

~~distal portions of the first and second channels are electrically insulated by a cover configured to electrically isolate portions of the first and second electrodes that reside within the blood vessel of the patient when the distal end of the catheter lumen is inserted into the blood vessel of the patient.~~

~~6. The catheter system of claim 4, wherein:~~

~~the first and second channels comprise closed channels; and~~

~~the first and second channels are at least partially skived to allow the first and second electrodes to be in electrical communication with each other via soft tissue between the first and second electrodes.~~

7. The catheter system of claim 4, further comprising:

a third electrode comprising an electrically conductive material placed within a third channel formed along the catheter lumen,

wherein the first, second, and third electrodes are spaced apart from each other along the outer lumen surface.

8. A catheter system comprising:

a catheter, the catheter comprising:

a catheter lumen comprising:

a proximal end;

a distal end;

an inner lumen surface; and

an outer lumen surface; and

a first electrode;

a second electrode; and

a blood sensor in communication with the first and second electrodes,

wherein when the distal end of the catheter lumen is inserted into a blood vessel of a patient:

at least a portion of the first and second electrodes are embedded within the blood vessel of the patient,

the first and second electrodes are in communication with each other via blood residing within the blood vessel of the patient, and

the blood sensor detects insertion of the distal end of the catheter lumen into the blood vessel of the patient by sensing at least one characteristic associated with the blood residing within the blood vessel of the patient.

9. The catheter system of claim 8, wherein the at least one characteristic associated with the blood residing within the blood vessel of the patient comprises at least one of:

an impedance;

an inductance;

a capacitance;

a pressure; and

an electromagnetic signal.

10. The catheter system of claim 8, further comprising:

a first attachment feature configured to couple the blood sensor to the first electrode; and

a second attachment feature configured to couple the blood sensor to the second electrode.

11. The catheter system of claim 8, wherein:

the first electrode comprises an electrically conductive material deposited on the outer lumen surface; and

the second electrode comprises an electrically conductive material deposited on the outer lumen surface,

wherein at least portions of the first and second electrodes are located proximate the distal end of the catheter lumen, and

the first and second electrodes are spaced apart from each other on the outer lumen surface.

12. The catheter system of claim 11, wherein the electrically conductive material comprises an electrically conductive ink.

13. The catheter system of claim 8, wherein:

the catheter lumen is made of an electrically conductive plastic;

the catheter lumen comprises the first electrode;

the catheter system further comprises an introducer needle; and

the introducer needle comprises the second electrode.

14. The catheter system of claim 13, wherein the blood sensor is configured to detect when the distal end of the catheter lumen is inserted into the blood vessel of the patient by sensing an electrical characteristic associated with the blood residing within the blood vessel of the patient between the catheter lumen and the introducer needle.

15. The catheter system of claim 14, wherein:

the inner lumen surface of the catheter lumen further comprises an electrically insulating layer; and

the blood sensor is configured to detect when the distal end of the catheter lumen is inserted into the blood vessel of the patient by sensing an electrical characteristic associated with the blood residing within the blood vessel of the patient between the distal end of the catheter lumen and a distal portion of the introducer needle.

16. A catheter system comprising:

a catheter, the catheter comprising:

a catheter lumen comprising:

a proximal end;

a distal end;

an inner lumen surface; and

an outer lumen surface; and

a drug sensing chip coupled to the catheter lumen,

wherein when the distal end of the catheter lumen is inserted into a blood vessel of a patient:

at least a portion of the drug sensing chip is embedded within a soft tissue of the patient adjacent the blood vessel, and

the drug sensing chip detects whether extravasation of a drug has occurred from the blood vessel into the soft tissue of the patient by sensing a characteristic associated with the soft tissue.

17. The catheter system of claim 16, wherein the drug sensing chip is configured to detect extravasation of the drug from the blood vessel into the soft tissue of the patient by sensing an impedance associated with the soft tissue of the patient.

~~18. The catheter system of claim 16, wherein the drug sensing chip is configured to detect extravasation of the drug from the blood vessel into the soft tissue of the patient by sensing at least one of:~~

~~a pressure associated with the soft tissue of the patient;~~

~~an inductance associated with the soft tissue of the patient;~~

~~an impedance associated with the soft tissue of the patient;~~

~~a capacitance associated with the soft tissue of the patient; and~~

~~an infrared signal associated with the soft tissue of the patient.~~

~~19. The catheter system of claim 16, wherein the drug sensing chip comprises an output device configured to provide an indication when extravasation of a drug from the blood vessel into the soft tissue of the patient has been detected.~~

~~20. The catheter system of claim 19, wherein the output device comprises an LED.~~

4. The catheter system of claim 1, wherein the proximal portion of the first electrode proximal to the first portion is parallel to the proximal portion of the second electrode proximal to the second portion.