

What is claimed is:

1. An electrical connector comprising:

a first electrical contact including a first substrate made of a first material and a first electrically conductive coating made of a second material that covers the first substrate, wherein the second material includes a sufficient amount by weight of a transition metal to form a non-conductive passivation layer on the first electrically conductive coating when the first electrical contact is immersed in an electrolytic environment; and

a second electrical contact configured to mate with the first electrical contact, wherein the second electrical contact includes a second substrate made of a third material and a second electrically conductive coating made of a fourth material that covers the second substrate, and wherein the fourth material includes a sufficient amount by weight of a transition metal to form a non-conductive passivation layer on the second electrically conductive coating when the second electrical contact is immersed in an electrolytic environment; and

wherein the first and third materials are different than the second and fourth materials, respectively, and wherein an initial thickness of the first and second electrically conductive coatings is such that abrasion associated with coupling and decoupling the first and second electrical contacts does not expose either of the first and second substrates.

2. The electrical connector of claim 1, wherein the first and third materials have respective electrical conductivities that are greater than respective electrical conductivities of the transition metals in the first and second electrically conductive coatings.

3. The electrical connector of claim 1, wherein the first and third materials are metals that are not capable of forming a non-conductive passivation layer when immersed in an electrolytic environment.
4. The electrical connector of claim 3, wherein the first and third materials each include a metal selected from the group consisting of copper, brass, aluminum, steel and titanium.
5. The electrical connector of claim 1, wherein the first and third materials are non-conductive.
6. The electrical connector of claim 5, wherein the first and third materials are selected from the group consisting of ceramic, glass, and polymer.
7. The electrical connector of claim 1, wherein the first and third materials each have at least one of an elastic modulus, a yield strength, and an ultimate strength that is greater than an elastic modulus, a yield strength, and an ultimate strength of the transition metal in the corresponding first and second electrically conductive coatings.
8. The electrical connector of claim 7, wherein the respective elastic moduli, yield strength, and ultimate strength of the first and third materials is at least 125% greater than the respective elastic moduli, yield strength, and ultimate strength of the transition metals in the first and second electrically conductive coatings.

9. The electrical connector of claim 1, wherein the first and second coatings include at least one self-passivating transition metal selected from the group consisting of: niobium (Nb), tantalum (Ta), titanium (Ti), zirconium (Zr), molybdenum (Mo), ruthenium (Ru), rhodium (Rh), palladium (Pd), hafnium (Hf), tungsten (W), rhenium (Re), osmium (Os), and iridium (Ir).

10. The electrical connector of claim 1, wherein the first and second contacts include contacting and non-contacting portions, and wherein respective thicknesses of the first and second electrically conductive coatings on the respective contacting portions are different than respective thicknesses of the first and second electrically conductive coatings on the respective non-contacting portions.

11. The electrical connector of claim 1, wherein respective thicknesses of the first and second electrically conductive coatings are no more than 40% of respective thicknesses of the first and second contacts.

12. A method of making an electrical connection in an electrolytic environment, the method comprising the steps of:

forming a non-conductive passivation layer on a first electrically conductive coating of a first electrical contact by immersing the first electrical contact in an electrolytic environment, wherein the first electrical contact includes a first substrate made of a first material and the first electrically conductive coating is made of a second material including a sufficient amount by weight of a transition metal to form a non-conductive passivation layer on the first electrically conductive coating when the first electrical contact is immersed in the electrolytic environment;

forming a non-conductive passivation layer on a second electrically conductive coating of a second electrical contact by immersing the second electrical contact in an electrolytic environment, wherein the second electrical contact includes a second substrate made of a third material and the second electrically conductive coating is made of a fourth material including a sufficient amount by weight of a transition metal to form a non-conductive passivation layer on the second electrically conductive coating when the second electrical contact is immersed in the electrolytic environment, wherein the first and third materials are different than the second and fourth materials, respectively;

mating the first and second electrical contacts in the electrolytic environment, wherein during the mating, sufficient portions of the non-conductive passivation layers are removed to allow the electrically conductive coatings to conduct electricity;

applying electrical power across the first and second electrical contacts in the electrolytic environment; and

de-mating the first and second electrical contacts in the electrolytic environment, wherein an initial thickness of the first and second electrically conductive coatings is such that abrasion associated with coupling and decoupling the first and second electrical contacts does not expose either of the first and second substrates.

13. The method of claim 12, wherein the first and third materials have respective electrical conductivities that are greater than respective electrical conductivities of the transition metals in the first and second electrically conductive coatings.

14. The method of claim 12, wherein the first and third materials each include a metal selected from the group consisting of copper, brass, aluminum, steel, and titanium.

15. The method of claim 12, wherein the first and third materials are non-conductive.
16. The method of claim 15, wherein the first and third materials each include a material selected from the group consisting of a ceramic, a glass, and a polymer.
17. The method of claim 12, wherein at least one of the respective elastic moduli, yield strength, and ultimate strength of the first and third materials is at least 125% greater than the respective elastic moduli, yield strength, and ultimate strength of the transition metals in the corresponding first and second electrically conductive coatings.
18. The method of claim 12, wherein the first and second coatings include at least one self-passivating transition metal selected from the group consisting of: niobium (Nb), tantalum (Ta), titanium (Ti), zirconium (Zr), molybdenum (Mo), ruthenium (Ru), rhodium (Rh), palladium (Pd), hafnium (Hf), tungsten (W), rhenium (Re), osmium (Os), and iridium (Ir) .
19. The method of claim 12, wherein the first and second contacts include contacting and non-contacting portions, and wherein respective thicknesses of the first and second electrically conductive coatings on the respective contacting portions are different than respective thicknesses of the first and second electrically conductive coatings on the respective non-contacting portions.

20. The method of claim 12, wherein respective thicknesses of the first and second electrically conductive coatings are no more than 40% of respective thicknesses of the first and second contacts.