

To Protect It, Something Must Dissolve First

— Attach zinc and the difference is **+0.32 V** and the iron is protected; attach copper and it is **−0.78 V** and the iron goes faster — the protector loses **10.6920 kg** per ampere-year — the same act of attaching a metal reverses sign — [Paper 440]

Yuuki YAMAGISHI (山岸 勇輝)

Yamagishi Complexity Torus Lab, Japan

September 2026

— *From thinking to syncing.* —

Abstract

Protecting a metal is thought to mean covering it. This paper shows that there is a way of protecting that does not cover but attaches something that dissolves first—and that attaching the wrong metal reverses the sign. No new theorem or law is claimed. First, attaching zinc to iron gives a difference of **+0.32 V** and the iron is protected (Section 2). Second, this is the core of the paper. Attaching copper gives **−0.78 V** and the iron dissolves faster than with nothing attached (Section 2). Third, magnesium gives **+1.93 V**, six times the figure for zinc (Section 2). Fourth, the protector is consumed: zinc loses **10.6920 kg** per ampere-year (Section 3). Fifth, magnesium loses **3.9747 kg**, and the ratio equals the ratio of atomic masses, **2.689981** (Section 3). Sixth, the separator is whether it covers or whether it is the baser potential (Section 4). **Keywords:** sacrificial anode, cathodic protection, galvanic corrosion, standard electrode potential.

Scope of this paper (scope note): No new theorem or law is claimed—standard electrode potentials, galvanic corrosion, sacrificial anodes and Faraday’s law are all standard.No electrochemistry is derived—the origin of potentials and the Nernst equation are used as known.No corrosion rate is predicted—a potential difference does not fix a current. Electrolyte conductivity, area ratios and polarisation all act, and none is treated here.The potentials are used conditionally—standard electrode potentials hold under particular conditions, and the ordering can change in real environments.No design is proposed—how much anode to place where is not the subject.No comparison with coatings—which method of protection is better is not the subject.Relation to earlier papers: Paper 439 showed that judder comes from the gap rather than the size of the friction—there too a difference was what acted; here it is a difference of potential.Paper 300 showed that common root and distinct root can be decided—“protecting by covering” and “protecting by dissolving first” are distinct roots by that criterion.Paper 437 showed that each choosing best lands both on the worst—there the pair had to be looked at; here the direction is only fixed once two metals are paired.Paper 419 showed that the same material differs in strength by orientation—here too, a quantity undetermined alone is fixed by the pairing.What is added is tabulating the potentials of four metals, giving the sign of the difference for three pairings, placing the copper case as the other side of the boundary, deriving the consumption of the protector from Faraday’s law, confirming by inversion that the ratio equals the ratio of atomic masses, and placing the separator at “covering or baser”.

1. Notation and the Question

Setting: Join two metals in an electrolyte and the baser dissolves while the nobler is protected. Take representative standard electrode potentials.

Metal	Potential [V]
Magnesium	−2.37
Zinc	−0.76
Iron	−0.44
Copper	+0.34

Write the difference from the iron’s side as $E_{\text{Fe}} - E_{\text{other}}$; positive means the iron is protected.

Observation 1.1

Protecting a metal is thought to mean covering it. Paint it, plate it, wrap it—the idea of shutting out water and air.

Observation 1.2

But a covering always gets scratched. And rust starts there—shutting out alone ends the moment a scratch appears.

Question: Is there a way that survives a scratch.

2. The Same Act of Attaching a Metal Reverses Sign

Computation 2.1: Take the difference for three metals joined to iron.

Pairing	Difference [V]	The iron
Iron + magnesium	+1.93	is protected
Iron + zinc	+0.32	is protected
Iron + copper	−0.78	dissolves faster

Observation 2.2

Copper reverses the sign. −0.78 V—the other side of the boundary: one and the same act of attaching a metal both protects and destroys.

Observation 2.3

So a copper fitting on an iron pipe concentrates the attack on the iron. Both are sturdy metals—looking at either alone gives no warning.

Observation 2.4

Magnesium gives six times the difference of zinc.1.93 against 0.32—stronger protection, and correspondingly faster consumption.

Observation 2.5

This is not a covering.The iron is protected even where its surface is exposed—which is why it keeps working after a scratch.

3. The Protector Is Consumed

Computation 3.1: From Faraday’s law, take the mass consumed by one ampere over one year.

Metal	Atomic mass	Valence	Consumed [kg]
Magnesium	24.305	2	3.9747
Zinc	65.380	2	10.6920

Observation 3.2

Zinc is consumed more heavily.10.6920 against 3.9747 kg—because carrying the same charge takes more mass when the atomic mass is larger.

Observation 3.3

The ratio equals the ratio of atomic masses exactly.2.689981—matching 65.380/24.305 to six decimal places, which is the inversion.

Observation 3.4

The valence does not appear in the ratio because it is the same. Both are 2—with different valences the ratio would depart from the ratio of masses.

Observation 3.5

Ten kilograms is not small. For one ampere over one year—to protect is to hand over material.

4. The Separator

The separator: does it cover, or is it the baser potential.

Observation 4.1

A covering protects by closing a surface. Open a hole and the attack concentrates there—the smaller the area, the higher the current density, so it goes faster than before.

Observation 4.2

A sacrifice protects by lowering the potential. The exposed iron is protected even through a hole—it does not require the surface to be continuous.

Observation 4.3

These are distinct roots by the criterion of Paper 300. Both are called “protection”—one a geometric property, one an electrochemical one.

Observation 4.4

Galvanising does both at once. It is a covering and a sacrifice—which is why a scratch does not immediately rust. Two mechanisms overlap; it is not one.

Observation 4.5

And the protector always shrinks. There is no sacrificial anode that does not—if it does not shrink, no current is flowing, which is the same as not working.

Observation 4.6

To be honest—a potential difference does not fix a current. Electrolyte conductivity, area ratios and polarisation all act—only the relation between direction and consumption is treated here, not the rate.

Observation 4.7

One last thing—standard electrode potentials hold under particular conditions. The ordering can change in real environments—what does not change is that the direction is only fixed once two metals are paired.

5. Roll Call and Closing

1. Iron + zinc gives **+0.32 V** (Computation 2.1): **protected**.
2. Iron + magnesium gives **+1.93 V** (Computation 2.1): **six times zinc**.
3. Iron + copper gives **−0.78 V** (Computation 2.1): **the sign reverses**.
4. A copper fitting concentrates the attack (Observation 2.3): **unforeseeable alone**.
5. Protection reaches exposed surface (Observation 2.5): **not a covering**.
6. Zinc loses **10.6920 kg per ampere-year** (Computation 3.1): **the protector goes**.
7. Magnesium loses **3.9747 kg** (Computation 3.1): **lighter**.
8. The ratio is **2.689981** (Observation 3.3): **the ratio of atomic masses**.
9. An anode that does not shrink is **not working** (Observation 4.5): **no current**.
10. The separator is covering or baser (Observation 4.3): **distinct roots by Paper 300**.

Closing: Protecting a metal is thought to mean covering it—paint it, plate it, wrap it—but a covering always gets scratched and rust starts there, so shutting out alone ends the moment a scratch appears. The other way is to attach something that dissolves first—joining zinc to iron gives a difference of **+0.32 V** and the iron is protected; magnesium gives **+1.93 V**, six times as much. This is not a covering, so the iron is protected even where its surface is exposed—which is why it keeps working after a scratch. But attaching the wrong metal reverses the sign—joining

copper gives **−0.78 V** and the iron dissolves faster than with nothing attached. Both are sturdy metals, so looking at either alone gives no warning: a copper fitting on an iron pipe concentrates the attack on the iron. And the protector is always consumed—by Faraday’s law, one ampere over one year takes **10.6920 kg** of zinc or **3.9747 kg** of magnesium. The ratio is **2.689981**, matching the ratio of atomic masses **65.380/24.305** to six decimal places, with the valence absent because it is the same for both. Ten kilograms is not small: to protect is to hand over material. One thing separates them—does it cover, or is it the baser potential. A covering protects by closing a surface, so a hole concentrates the attack and the smaller the area the higher the current density, making it worse than before. A sacrifice protects by lowering the potential and does not require the surface to be continuous. They are distinct roots by the criterion of Paper 300, one geometric and one electrochemical. Galvanising does both at once, which is why a scratch does not immediately rust—two mechanisms overlapping, not one. And there is no sacrificial anode that does not shrink: if it does not, no current is flowing, which is the same as not working. To be honest—a potential difference does not fix a current. Electrolyte conductivity, area ratios and polarisation all act, and only the relation between direction and consumption is treated here. One last thing—standard electrode potentials hold under particular conditions and the ordering can change in real environments. What does not change is that the direction is only fixed once two metals are paired.

References

1. Davy, H. (1824). On the Corrosion of Copper Sheeting by Sea Water. *Philosophical Transactions of the Royal Society*.
2. Pourbaix, M. (1974). *Atlas of Electrochemical Equilibria in Aqueous Solutions*. Houston: NACE.
3. Jones, D. A. (1996). *Principles and Prevention of Corrosion* (2nd ed.). Upper Saddle River: Prentice Hall.
4. Revie, R. W., & Uhlig, H. H. (2008). *Corrosion and Corrosion Control* (4th ed.). Hoboken: Wiley.
5. Yamagishi, Y. (2026). *The Three Hundredth Census: Whether Two Things Share a Root Is Decidable* [Paper 300]. Zenodo. 10.5281/zenodo.22171914
6. Yamagishi, Y. (2026). *The Same Material, the Same Shape, and the Orientation Decides* [Paper 419]. Zenodo. 10.5281/zenodo.22699940
7. Yamagishi, Y. (2026). *Each Choosing Best Lands Both on the Worst* [Paper 437]. Zenodo. 10.5281/zenodo.22709472
8. Yamagishi, Y. (2026). *What Makes It Judder Is Not the Size of the Friction but the Gap Between Two* [Paper 439]. Zenodo. 10.5281/zenodo.22732357

— *From thinking to syncing.* —

Yuuki YAMAGISHI (山岸 勇輝)