

## Electrolysis of Metals

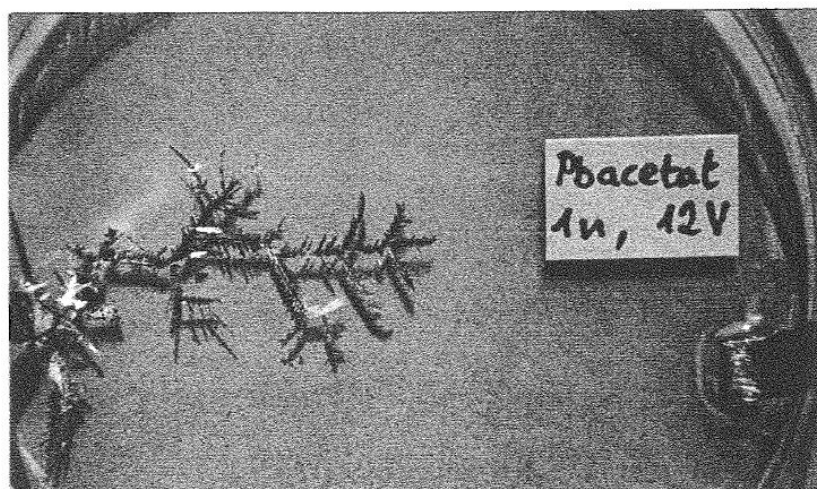
### Lead



Lead "tree"



Lead "beard"



Electrolysis in the petri dish

## Experiments in Electrolysis

### Lead

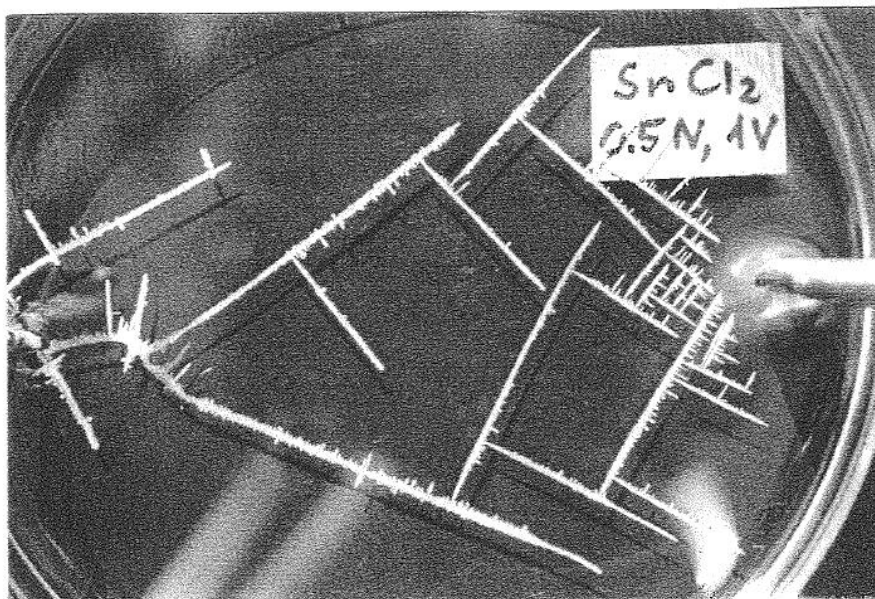
#### Lead "tree":

When a solution of lead acetate (1 N, for example) is electrolyzed, lead precipitates at the cathode in very characteristic "tree" shapes. At low voltages (e.g., 2 volts), lead "trees" appear: Enchanting little lead-gray metal platelets are arranged in multi-branched, fernlike formations that are shiny and glitter in the light. For this experiment, a 250 mA power supply is sufficient, and the reaction can take place in a small beaker.

At higher voltages such as 220 volts, metallic white "beards" rapidly develop in the direction of the current. These beards are reminiscent of the strands of moss that hang from trees in humid climates.

A dense lead beard develops slowly when a piece of filter paper is suspended from alligator clip in the lead acetate solution and a 12 volt current is passed through the solution. More rapid growth (still at 12 volts) can be obtained in a petri dish with its bottom covered with a 1 N solution of lead acetate. When the plane of crystallization is parallel to the bottom of the dish, the typical lead "tree" forms result. It may sometimes be necessary to help the process along by using a flat spatula to carefully press the crystals to the bottom.

## Tin



Electrolytic deposition of tin

### Electrolysis:

HCl is added slowly, drop by drop, to a freshly prepared 0.5 N solution of  $\text{SnCl}_2$  until the solution is completely clear. (The acid must be added slowly because the solution becomes clear only gradually.) In the event that the solution does not become clear, it must be filtered.

10 ml of the solution is placed in a petri dish with a diameter of approximately 11 cm and then electrolyzed between tin electrodes. Very shiny tin crystals develop in straight lines with right-angled branching. They almost always lie all in a single plane and must grow parallel to the bottom of the dish if they are to develop properly. If the plane of crystallization is perpendicular to the bottom, the crystal does not branch but grows in tight zigzags between the glass surface and the surface of the liquid and may be either more or less straight or bent. Again, the crystals can be pressed to the bottom with a spatula to allow them to branch in a plane.

A 0.5 N solution at 1 volt yields rapid, variably branched, needle-like growth and forms very attractive shapes. Increasing the voltage to 2 volts can speed up growth. At higher concentrations, the crystals cover a larger surface area. Alkaline solutions yield only radial, two-dimensional formations, regardless of the voltage applied.

When 1 to 2 N solutions of tin tetrachloride are used and higher voltages are applied, tin precipitates are much slower to develop and are fine-textured and two-dimensional. At the same time, a white precipitate of stannic acid develops at the anode.

## Iron

### Electrolysis:

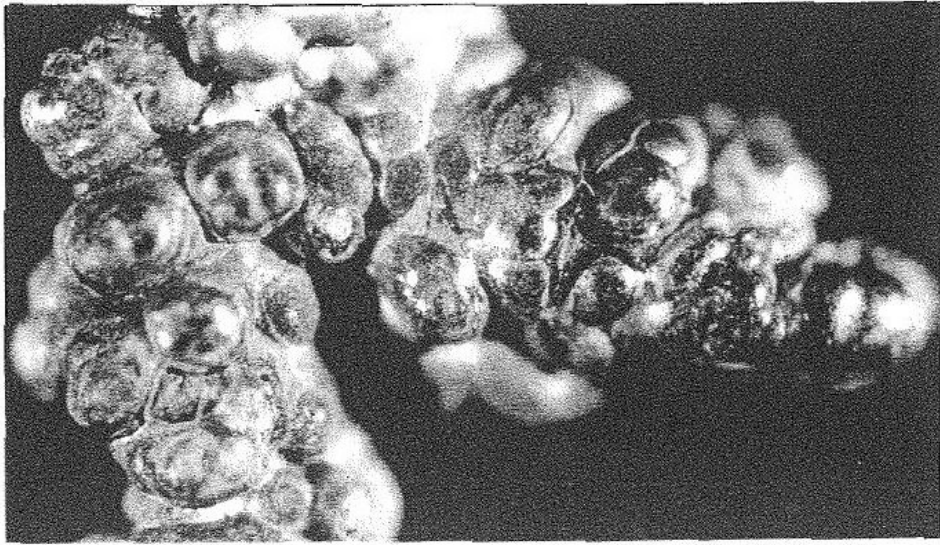
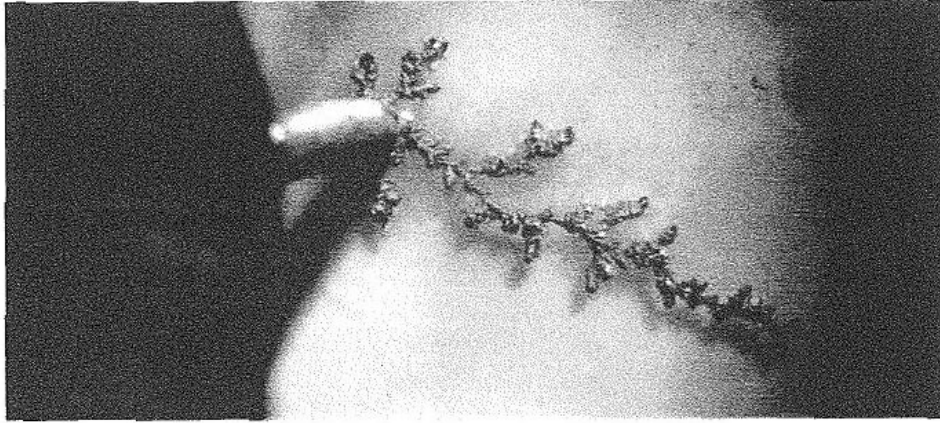
A 10 cm petri dish is first cleaned with commercial scouring powder and rinsed thoroughly. 10 ml of the electrolyte solution are poured into it, covering the bottom. The anode should be inserted flat and be fully submerged. It will need to be cleaned between uses because the anode sludge that develops on it may impede the flow of electricity. The cathode should be pointed, although the tip can be somewhat rounded; it should barely dip below the surface of the liquid.

A 6 N iron (II) solution is then produced (6g  $\text{FeCl}_2 \cdot 4\text{H}_2\text{O}$  in 10 ml of solution) and an applicator tip of powdered iron is added and stirred in. The solution is then filtered. The filtrate must be pure bottle-green and must be used immediately. During electrolysis, a corona of iron (III) chloride, initially yellow but then becoming brown, develops around the iron anode. A brownish ring also gradually develops around the cathode.

As a rule, electrolytically precipitated iron forms massive, tree-like aggregates rather than distinct crystals. Growth is accelerated at higher temperatures and at higher concentrations of divalent iron in the solution. In experiments conducted at room temperature and at 12 volts, deposition out of a 6 N solution of  $\text{FeCl}_2$  begins slowly, accompanied by the development of hydrogen. Reducing the distance between electrodes to about 4 cm is recommended.

Under the microscope, we can see that the branches consist of little conjoined bowls or globules resembling kidney iron ore. The uppermost layer of bowls is often incompletely developed. Formations that are similar in structure but irregularly elongated or club-shaped may also occur, especially near the anode as growth accelerates. If the current is shut off and the iron remains damp, it quickly develops a brown oxide coating. If one of the globules can be broken open, the bowl-like structure of the massive iron can be seen under the microscope. Often the precipitate is light and interspersed with bubbles of gas.

Quick growth sometimes also results in metallic, iron-gray, plant-like crystals. These crystals tend to grow in a downward curve and eventually force themselves up out of the liquid, where they break off.



Electrolytic deposition of iron out of a 6 N solution of  $\text{FeCl}_2$