

MACROETCHANTS

(a) Aluminum and its Alloys

Common Name	Reagent	Applications and remarks
Keller's reagent	2-5% nitric acid 1-5% hydrochloric acid 0-5% hydrofluoric acid Water	Widely applicable to aluminum alloys. Concentration of constituents in reagent can be varied to obtain desired effect. Primarily used for grain flow, porosity, cracks, etc.
Tucker's reagent	3 parts (vol.) nitric acid 9 parts (vol.) hydrochloric acid 3 parts (vol.) hydrofluoric acid 5 parts (vol.) water	As Keller's reagent
Anodic treatment	Anodizing solutions	(i) Following anodizing, wash to remove anodizing solution, but do not seal (i.e. by drying in hot water rinse). Allow to stand for 24 hours. Cracks and flaws such as porosity are revealed by brown stains. (ii) Will also reveal grain flow, particularly on forgings, bar and plate material.

(b). Copper and its alloys

	Concentrated nitric acid	Grain etch, suitable for roughly prepared surfaces.
Alcoholic ferric chloride	25-60g ferric chloride 2-30ml hydrochloric acid Alcohol	General purpose macroetch. Surface generally needs to be prepared to a moderately high standard. With high acid concentrations it is best to replace the alcohol with water in which case the solution becomes aqueous ferric chloride. Best used fresh.

(c) Magnesium and its alloys

	2% ammonium persulphate 10% tartaric acid in water	Grain flow in forgings. Can replace the tartaric acid with citric, acetic, oxalic, and nitric acids.
--	-------------------------------------------------------	------------------------------------------------------------------------------------------------------

MACROETCHANTS

(d) Ferrous alloys

Sulphur printing	3% sulphuric acid in water	Prepare steel surface to about 600 emery, soak photographic paper in reagent, remove surplus reagent from paper with blotting paper, and apply the photographic paper to the prepared steel surface. Allow 2-3 min, then remove and fix in normal photographic fixer. Brown coloration indicates sulphide segregation.
Stead's reagent	10g cupric chloride 40g magnesium chloride 20ml hydrochloric acid (conc.) Alcohol to 1L	Dissolve salts in acid with min. addition of water. Make up to 1 L with alcohol. Phosphorus segregation is unattacked, also reveals dendritic structure of cast steels.
Fry's reagent	90g cupric chloride 120ml hydrochloric acid 100ml water	Strain lines in mild steel are revealed by heating the sample to about 500F for 10-15min, prior to etching. Use a swab.
Humphrey's reagent	120g copper ammonium chloride 50ml hydrochloric acid 1 L water	Pre-treat surface of sample with an 8% copper ammonium chloride solution then immerse sample in reagent for 1 to 2 hours. Copper deposit is loosely adherent and is removed with a fine abrasive. Shows dendrite structure of cast steels.
	140ml hydrochloric acid 3 ml sulphuric acid 50 ml water	Immerse specimen in reagent at 200F for 15-30 min. deep etch reveals segregation, porosity, cracks, etc.
	10g ammonium persulphate 90ml water	Use with swab. Reveals variations in crystal structure, grain growth.
	10ml nitric acid (conc.) 90ml water	Use with swab. Reveals variations in crystal structure, grain growth.
10% natal	10% nitric acid in alcohol.	May need up to 1h immersion. Reveals cracks, porosity, grain, etc. Specimen should be prepared to about 400 grit emery.

(e) Nickel base alloys

Aqua regia	50% Nitric acid 50% acetic acid 1 volume nitric acid 3 volume hydrochloric acid	General purpose reagent.
-------------------	------------------------------------------------------------------------------------------	--------------------------

MACROETCHANTS

(f) Lead base alloys

Russell's reagent	(a) 80ml nitric acid in 220ml water (b) 45g ammonium molybdate in 300 ml water.	Mix equal parts of (a) and (b) immediately before use. Grain contrast etch.
	10 g ammonium molybdate 25g citric acid 100ml water	Bright etch for revealing grain structure, defects, etc.

(g) Zinc base alloys

	Concentrated hydrochloric acid	Grain contrast etch.
	5% hydrochloric acid in alcohol	General purpose etch.