

Etchants for Iron and Steel

Nital

1-10 mL HNO₃
 90-99 mL ethanol or methanol

Most common etchant for Fe, carbon and alloy steels, cast irons. Reveals alpha grain boundaries and constituents. The 2% solution is the most common. Use by immersion for up to 60 seconds or by swabbing. Do not store ethanolic solutions that exceed 2% nitric acid. The 5-10% solution is used for high-alloy steels, should not be stored if made with ethanol. (Boylson)

Picral

4g picric acid
 100 mL ethanol

Recommended for structures consisting of ferrite and carbide. Does not reveal ferrite grain boundaries. Addition of 0.5-1% zephiran chloride (a commonly used antibacterial agent) improves etch rate and uniformity. Use by immersion for up to 60 seconds or by swabbing. (Ljevski)

Glyceria

3 parts HCl
 2 parts glycerol
 1 part HNO₃

For high alloy steels, austenitic Mn steels, stainless steels and Ni-based alloys. Reveals grain structure, outlines sigma and carbides. Use fresh. Discard when turns yellow/orange. Do not store. For slower action and martensitic ferrite stainless steel, use 2 parts HCl. Swab sample 5-30 seconds.

Vilella's Reagent

1g picric acid
 5 mL HCl
 100 mL ethanol

For high alloy steels and stainless steels. Use at 20°C for up to 1 minute by immersion or swabbing. Outlines constituents such as carbides, sigma phase, and delta ferrite; etches martensite.

Etchants for Copper and Alloys

25 mL NH₄OH
 25 mL distilled water (optional)
 25-50 mL H₂O₂ (3%)

General purpose grain contrast etch for Cu and alloys (does not always produce grain contrast.) Use fresh, add peroxide last. Use under a fume hood. Swab sample 5-45 seconds.

5g Fe (NO₃)₃
 25 mL HCl
 70 mL distilled water

Excellent general purpose etch, reveals grain boundaries well. Immerse sample 10-30 seconds. (Stepian and Prohaska)

Etchants for Aluminum and Alloys

0.1-10 mL HF
 90-100 mL distilled water

General purpose reagent. Attacks FeAl₃ other constituents outlined. Grain contrast usually poor. The 0.5% concentration of HF is very popular. Use by swabbing.

Keller's Reagent

2.5 mL HNO₃
 1.5 mL HCl
 1 mL HF
 95 mL distilled water

Very popular general purpose reagent for Al and Al alloys, except high Si alloys. Swab sample 10-20 seconds. Wash in warm water. Can follow with a dip in concentrated HNO₃. Outlines all common constituents, reveals grain boundaries in certain alloys.

Etchants for Nickel and Alloys

Kalling's No. 2

2g Cu Cl₂
 40 mL HCL
 40-80 mL ethanol

"Waterless Kalling's" for Ni-Cu, superalloys and stainless steels. Good for grain size. Swab for up to a few minutes. Can be stored.

Acetic Glyceria

15 mL HCl
 10 mL acetic acid
 5 mL HNO₃
 1-2 drops glycerol (optional)

For superalloys. Use fresh. Discard when turns yellow/orange. Do not store. Swab sample 5-30 seconds.

Etchants for Titanium and Alloys

Kroll's Reagent

1-3mL HF
 2-6 mL HNO₃
 100 mL distilled water

Very good etch. Swab sample 3-10 seconds or immerse sample 10-30 seconds.

Notes: Etchants Table

* In all reagents when water is specified, distilled water should be used. Reagent-grade chemical, acids, bases, solvents, etc. should be used for best results. Use face hoods, goggles, gloves and any other equipment to ensure proper lab safety. Particular care should be used when working with HF, as it is a very strong chemical. For those unfamiliar with safe laboratory procedures, training is highly recommended.

** Reproduced from Vander Voort, George, "Metallography Principles and Practice", ASM International, Materials Park, OH, 1999.

Grit Equivalency Guide

FEPA (Europe)		ANSI/CAMI (USA)		
Grit Number	Size (µm)	Grit Number	Size (µm)	Emery Grit
P60	269.0	60	268.0	
P80	201.0	80	188.0	
P100	162.0	100	148.0	
P120	127.0	120	116.0	
P180	78.0	180	78.0	3
P240	58.5	220	66.0	2
P280	52.2	240	51.8	
P320	46.2			
P360	40.5	280	42.3	1
P400	35.0	320	34.3	0
P500	30.2	360	27.3	
P600	25.8	400	22.1	00
P800	21.8			
P1000	18.3	500	18.2	000
P1200	15.3	600	14.5	
P1500	12.6	800	12.2	0000
P2000	10.3	1000	9.2	
P2500	8.4	1200	6.5	
P4000*	5.0*			

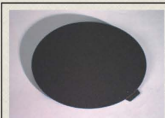
The chart shows the grit points for the size ranges for ANSI/CAMI graded paper according to ANSI standard B74. 18-1995 and for FEPA graded paper according to FEPA standard 49-GB-1984 (R1-1995). The ANSI/CAMI standard lists SIC particle size ranges up to 600 grit paper. For the grit ANSI/CAMI papers, the particle size comes from the CAMI booklet, Coated Abrasives (1998).

* FEPA grits finer than P2000 are not standardized and are graded at the discretion of the manufacturer. In practice, the above standardized values are only guidelines and individual manufacturers may wish to a different size range and mean value.



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