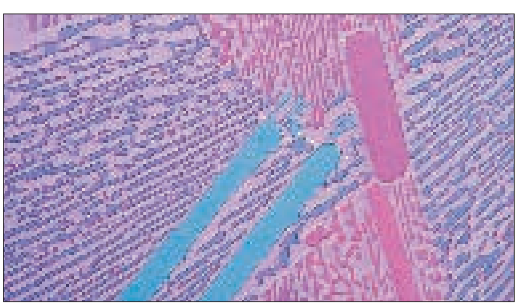
LOW-MELTING POINT METALS: Sb, Bi, Cd, Pb, Sn and Zn

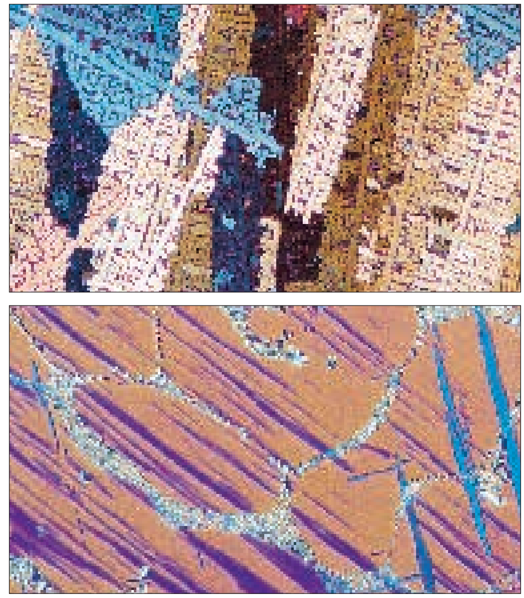
30 Zn Zinc | 48 Cd Cadmium | 50 Sn Tin

51 Sb Antimony | 82 Pb Lead | 83 Bi Bismuth

As pure metals, antimony, bismuth, cadmium, lead, tin, and zinc are all very soft and difficult to prepare. Pure antimony is quite brittle, but alloys containing Sb are more common. Bismuth is a soft metal, but brittle, and not difficult to prepare. However, retaining bismuth particles in free machining steels is difficult. Cadmium and zinc, both with hexagonal close-packed crystal structures, are quite prone to mechanical twin formation if sectioning or grinding is performed too aggressively. Zinc is harder than tin or lead and tends to be brittle. Zinc is widely used to coat sheet steel (galvanized steel) for corrosion protection, and is a common metallographic subject. Pure zinc is very difficult to prepare. Lead is very soft and ductile and pure specimens are extremely difficult to prepare; however, lead alloys are considerably easier. Tin, which is allotropic with a body-centered tetragonal crystal structure at room temperature, is soft and malleable and less sensitive to twinning. Pure tin, like pure lead, is very difficult to prepare. Due to their low melting points, and low recrystallization temperatures, cold setting resins are usually recommended as recrystallization may occur during hot compression mounting. Some of these metals in the pure, or nearly pure form, will deform under the pressures used in compression mounting. Alloys of these metals are easier to prepare, as they are usually higher in hardness. Heating of surfaces during grinding must be minimized. Grinding of these metals is always difficult, as SiC particles tend to embed heavily.



Proeutectic dendrites of Cu_2Sb surrounded by a eutectic mixture of antimony and Cu_2Sb, in an as-cast Sb – 30% Cu specimen (unetched, polarized light, 200X).



(top) Cadmium dendrites and a Cd-Bi eutectic in an as-cast Cd – 20% Bi alloy (unetched, crossed polarized light plus sensitive tint, 50X). (bottom) As-cast microstructure of Zn – 0.1% Ti – 0.2% Cu alloy exhibiting mechanical twins and a three-phase eutectic (alpha-Zn, Cu-Zn and $Zn_{15}Ti$) in a cellular pattern (Palmerton reagent, crossed polarized light plus sensitive tint, 200X).

Many authors have recommended coating the SiC paper surface with bees wax, but this does not solve the problem. Paraffin (candle wax) is much better for reducing embedding. Embedding is most common with the finer grit size papers. Diamond is not a very effective abrasive with these metals. Alumina works quite well. Following is a procedure for these alloys, see Table 15.

For best results, follow this with a vibratory polish using MasterMet colloidal silica on MicroCloth pad for times up to 1-2 hours. This will improve polarized light response for the hcp Cd and Zn and the rhombohedral Bi. The 1µm alumina step will remove any embedded silicon carbide particles much more effectively than a diamond abrasive step.

Helpful Hints For Low-Melting Point Metals

Embedment of fine abrasive particles is a common problem when preparing soft, low-melting point specimens. To reduce embedment of SiC abrasive particles, coat the paper with wax before grinding. Johnson (*Wear*, Vol. 16, 1970, p. 351-358) showed that candle wax is far more effective than paraffin. However, if the layer is applied too thickly, the metal-removal rate in grinding will be reduced drastically.

Table 15: 6-Step Method for Low-Melting Temperature Alloys

Sectioning	Precision saw, with a 30HC blade recommended for use on soft gummy materials
Mounting	Castable, typically with EpoThin

Surface	Abrasive / Size	Load - lbs [N] / Specimen	Base Speed [rpm]	Relative Rotation	Time [min:sec]
CarbiMet 2	320 [P400] grit SiC water cooled (wax coated)*	4 [18]	150		Until Plane
CarbiMet 2	400 [P800] grit SiC water cooled (wax coated)*	4 [18]	150		1:00
CarbiMet 2	600 [P1200] grit SiC water cooled (wax coated)*	4 [18]	150		1:00
CarbiMet 2	1200 [P2500] grit SiC water cooled (wax coated)*	4 [18]	150		1:00
MicroFloc	1µm MicroPolish II Alumina	5 [22]	150		5:00
MicroFloc	0.05µm MicroPolish II Alumina**	4 [18]	150		4:00

= Platen *= Specimen Holder*

**Rub candle was lightly across rotating disc prior to grinding* ***See vibratory polish recommendation in text*

Imaging & Analysis	Grain Size, Measurement & Analysis applications
Hardness Testing	N/A