SMOOTH SLIDING

Consulting company providing engineering services on issues related to sliding bearings

Copper Based Bearing Materials

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1. Introduction

The design of internal combustion engines has a tendency of decreasing the engine dimensions. This tendency leads to more compact bearings and consequently to higher specific alternating loads applied to them.

Copper based engine bearing materials provide superior fatigue strength (load capacity).

Copper based bearing alloys commonly contain tin (up to 10%) as a strengthening component and a soft component (lead or bismuth) distributed in a copper-tin matrix as a separate phase in form of small particles.
Soft component imparts to the material anti-friction properties (compatibility, conformability, embeddability).
Maximum content of soft phase is about 25%.
Copper based bearing alloys are manufactured by either casting or sintering technology.

Typical microstructures of copper based bearing materials are depicted in Fig.1, 2 (scanning electron microscope).

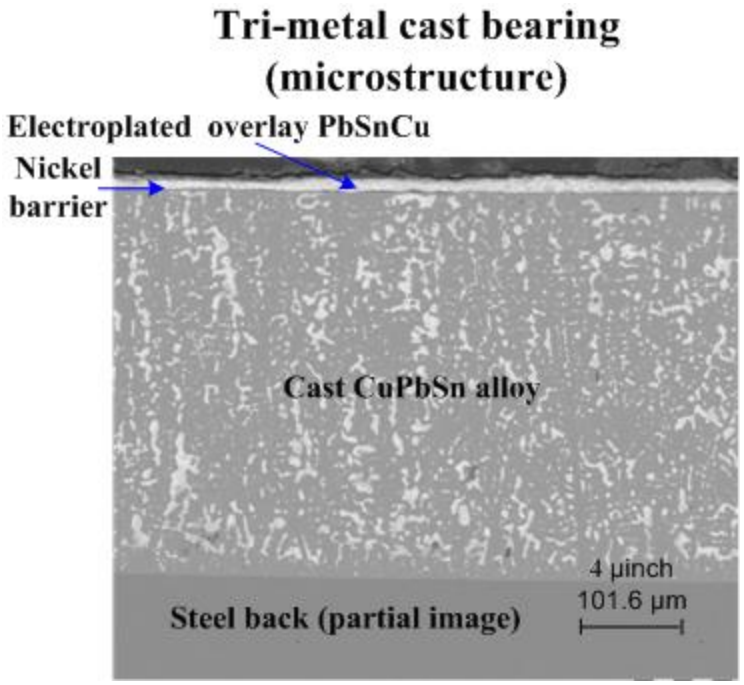
Tri-metal cast bearing
(microstructure)
Electroplated overlay PbSnCu
Nickel
barrier
Cast CuPbSn alloy
Steel back (partial image)
4 µinch
101.6 µm

Fig.1

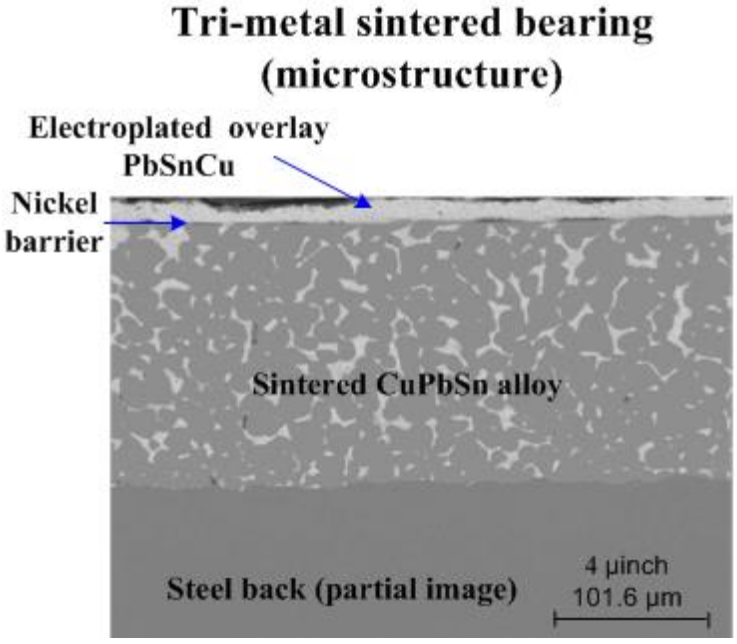
Tri-metal sintered bearing
(microstructure)
Electroplated overlay
PbSnCu
Nickel
barrier
Sintered CuPbSn alloy
Steel back (partial image)
4 µinch
101.6 µm

Fig.2

Despite the presence of soft components in most copper based bearing alloys their anti-friction properties are poor therefore copper (bronze) bearings are rarely used in engines in mono-metal (solid) or bi-metal (steel backed) forms.
Typical copper bearings are steel backed and overplated with a thin sliding layer (overlay) of a soft material (tri-metal structure). The overlay improves the anti-friction properties of the copper alloy.

Modern copper based bearing alloys do not contain lead because of its harmful effect on the environment. Lead in lead free alloys may be substituted by harmless bismuth having excellent anti-friction properties comparable with lead.

Load carrying capacity of copper based bearings is determined by the fatigue strength of the overlays:

- Lead based overlays: 7250-10150 psi (50-70 MPa)
- Tin based overlays: 11600-13000 psi (80-90 MPa)
- Sputter overlays: 14500-17400 psi (100-120 MPa)

2. Characteristics of Some Copper Based Engine Bearing Materials

Composition	Technology	Structure	Hardness, HV	Diffusion barrier	Overlay	Applications
CuPb25Sn1	Cast	Tri-metal	55	Nickel	Pb10Sn2Cu	Low loaded bearings
CuPb23Sn1.5	Cast	Tri-metal	60	Nickel	Al20Sn sputter	Highly loaded conrod bearings
CuPb23Sn1.5	Cast	Tri-metal	60	no or Nickel	Pb10Sn12In	Medium and highly loaded bearings
Cu24Pb243.5Sn	Cast	Multilayer	65	Nickel	Pb10S3Cu + MoS2 in resin	Racing car engine bearings
Cu20Pb3Sn	Cast	Tri-metal	65	Nickel	Pb10Sn3Cu	Medium loaded bearings
Cu15Pb7Sn	Cast	Bi-metal	80	no	no	Small end bushes
Cu15Pb7Sn	Cast	Solid	80	no	no	Thrust washers

Cu10Pb10Sn	Cast	Bi-metal	100	no	no	Highly loaded Small end bushes
Cu10Pb10Sn	Cast	Solid	100	no	no	Highly loaded Small end bushes
Cu8Al	Cast	Solid	145	no	no	Highly loaded bushes, lead free
Cu24Pb1Sn	Sintered	Tri-metal	55	Nickel	Pb10Sn2Cu	Low loaded bearings
Cu5Sn1Ag	Sintered	Tri-metal	80	no	MoS2 in resin	Medium loaded bearings, lead free
Cu22Pb1Sn	Sintered	Multilayer	55	Nickel	NiSn + SnCu	Medium and highly loaded bearings
Cu24Pb3.5Sn	Sintered	Tri-metal	65	Nickel	Pb10Sn3Cu	Medium loaded bearings
Cu20Pb4.5Sn	Sintered	Tri-metal	70	Nickel	Pb10Sn5Cu	Medium and highly loaded bearings
Cu10Pb10Sn	Sintered	Bi-metal	100	no	no	Highly loaded Small end bushes
Cu4Bi10Sn	Sintered	Bi-metal	130	Nickel	Pb10Sn3Cu	Highly loaded bearings, bushes, lead free