

List of Figures

- Fig.2.1 : Pictorial view of the configurations of commercially used contacts with base- plates.
- Fig.2.2 : Schematic view of mechanical alloying set-up alongwith resultant microstructural change
- Fig.2.3 : Schematic microstructures of Ag CdO contacts prepared by (a) conventional PM route, (b) internal oxidation process and (c) L-type contacts.
- Fig 2.4 : Schematic of (a) laboratory scale freezing set-up and (b) freeze dryer
- Fig 2.5 : Diagram showing stages of manufacture of silver-cadmium oxide contacts by internal oxidation.
- Fig 2.6 : Diagrammatic view of press-sinter-repress route.
- Fig 2.7 : Diagrammatic view of press-sinter-extrude route
- Fig 2.8 : Schematic of roll-compaction technique
- Fig 2.9 : Flow-sheet of various processing routes of AgCdO contact material on a comparative basis.
- Fig 2.10 : Schematic of (a) principal mechanical components and (b) electrical power circuit of contact test set-up.
- Fig 2.11 : Schematic of contact test set-up developed at LCIE - (a) operating parts and (b) electrical circuit diagram.
- Fig.2.12 : Schematic of DC contact testing switch
- Fig.2.13 : Plot of mean cross-section chord length of oxide particle versus lithium content
- Fig.2.14 : Effect of lithium addition on as- sintered density of Ag-CdO contacts.
- Fig 2.15 : Arc erosion loss for Ag-CdO-Li₂O and Ag-CdO- Li₂CO₃ systems.

Fig 3.1 : Probability number distribution plot for silver powder.

Fig 3.2 : Probability number distribution plot for CdO powder

Fig 3.3 : Probability number distribution plot for ZnO powder

Fig 3.4 : Schematic of spray-coprecipitation set-up

Fig 3.5 : Sketch of the freeze-dryer

Fig 3.6 : Photographs showing design aspects of attritor

Fig 3.7 : Photograph of the sintering furnace alongwith temperature programmer controller.

Fig 3.8 : Photograph of the hot- pressing set-up

Fig 3.9 : Photograph of the contact force measurement set-up.

Fig 3.10 : Photograph of the contact testing set-up for a pair of contacts

Fig 3.11 : Photograph of the brazed contact tips alongwith copper lugs

Fig 3.12 : Photograph of the test-contactor assembly and a single contact tip shown separately.

Fig 3.13 : Circuit diagram of the AC contact testing set-up

Fig 3.14 : Pictorial view of the AC contact testing set-up

Fig 3.15 : Programme flow-chart for AC contact testing

Fig 3.16 : Circuit diagram of the mV measurement set-up

Fig 3.17 : Photograph of the DC contact testing set-up

Fig 3.18 : Photograph of the brazed-contact assembly tested at NML, Jamshedpur.

Fig 4.1 : XRD profile for silver powder

Fig 4.2 : XRD profile for cadmium oxide powder

Fig 4.3 : XRD profile for zinc oxide powder

- Fig 4.4 : Multiple XRD profiles for Ag ZnO blended powders
- Fig 4.5 : Multiple XRD profiles for Ag ZnO coprecipitated powders
- Fig 4.6 : Multiple XRD profiles for Ag ZnO electroless-coated powders
- Fig 4.7 : Multiple XRD profiles for Ag ZnO freeze-dried powders
- Fig 4.8 : Multiple XRD profiles for Ag CdO blended powders
- Fig 4.9 : Multiple XRD profiles for Ag CdO coprecipitated powders
- Fig 4.10 : Multiple XRD profiles for Ag CdO electroless-coated powders
- Fig 4.11 : Multiple XRD profiles for Ag CdO freeze-dried powders
- Fig 4.12 : Plots of relative peak intensity (%) of ZnO phase versus milling time for Ag ZnO (MA) powders
- Fig 4.13 : Plot of relative peak intensity (%) of CdO phase versus milling time for AgCdO (MA) powders
- Fig 4.14 : Plot of relative peak intensity (%) for Ag (200) line versus milling time for Ag ZnO (MA) and Ag CdO (MA) powders
- Fig 4.15 : Plot of FWHM value for Ag (200) line versus milling time for AgZnO and AgCdO (MA) powders
- Fig 4.16 : Multiple plots for probability number distribution for Ag 7.1 ZnO system
- Fig 4.17 : Multiple plots for probability number distribution for Ag 8.6 ZnO system
- Fig 4.18 : Multiple plots for probability number distribution for Ag 10.8 ZnO system
- Fig 4.19 : Multiple plots for probability number distribution for Ag 10 CdO system
- Fig 4.20 : Multiple plots for probability number distribution for Ag 12 CdO system
- Fig 4.21 : Multiple plots for probability number distribution for Ag 15 CdO system

- Fig 4.22 : Histograms for apparent and tap density of Ag ZnO powders
- Fig 4.23 : Histograms for apparent and tap density of Ag CdO powders
- Fig 4.24 : Histograms for percentage rise in density on tapping for Ag ZnO powders
- Fig 4.25 : Histograms for percentage rise in density on tapping for Ag CdO powders
- Fig 4.26 : Optical micrographs for Ag ZnO (MA) powders at different milling times
- Fig 4.27 : Optical micrographs for Ag CdO (MA) powders at different milling times
- Fig 4.28 : SEM micrographs for (a) silver, (b) cadmium oxide and (c) zinc oxide powders
- Fig 4.29 : SEM micrographs for Ag ZnO (B) powders
- Fig 4.30 : SEM micrographs for Ag CdO (B) powders
- Fig 4.31 : SEM micrographs for Ag ZnO (C) powders
- Fig 4.32 : SEM micrographs for Ag CdO (C) powders
- Fig 4.33 : SEM micrographs for Ag ZnO (F) powders
- Fig 4.34 : SEM micrographs for Ag CdO (F) powders
- Fig 4.35 : SEM micrographs for Ag ZnO (E) powders
- Fig 4.36 : SEM micrographs for Ag CdO (E) powders
- Fig 4.37 : SEM micrographs for Ag ZnO (MA) and Ag CdO (MA) powders
- Fig 4.38 : XPS spectra of Ag ZnO (E) powder samples
- Fig 4.39 : XPS spectra of Ag CdO (E) powder samples
- Fig 4.40 : DTA / TGA trace for Ag ZnO powder sample
- Fig 4.41 : DTA / TGA trace for Ag CdO powder sample
- Fig 4.42 : Variation of density with compaction pressure for Ag 8.6 ZnO (B) system
- Fig 4.43 : Variation of density with compaction pressure for Ag 12 CdO (B) system
- Fig 4.44 : Variation of sintered density with sintering temperature for Ag 8.6 ZnO (B) and Ag 12 CdO (B) system

Fig 4.45 : Variation of sintered density with sintering time for Ag 8.6 ZnO (B) and

Ag 12 CdO (B) system

Fig 4.46 : Histograms showing microhardness for Ag ZnO system

Fig 4.47 : Histograms showing microhardness for Ag CdO system

Fig 4.48 : Variation of electrical conductivity with percent oxide phase for

Ag ZnO (B) system

Fig 4.49 : Variation of electrical conductivity with percent oxide phase for

Ag ZnO (C) system

Fig 4.50 : Variation of electrical conductivity with percent oxide phase for

Ag ZnO (E) system

Fig 4.51 : Variation of electrical conductivity with percent oxide phase for

Ag ZnO (F) system

Fig 4.52 : Variation of electrical conductivity with percent oxide phase for

Ag CdO (B) system

Fig 4.53 : Variation of electrical conductivity with percent oxide phase for

Ag CdO (C) system

Fig 4.54 : Variation of electrical conductivity with percent oxide phase for

Ag CdO (E) system

Fig 4.55 : Variation of electrical conductivity with percent oxide phase for

Ag CdO (F) system

Fig 4.56 : Optical micrographs for Ag ZnO (B) samples

Fig 4.57 : Optical micrographs for Ag CdO (B) samples

Fig 4.58 : Optical micrographs for Ag ZnO (C) samples

Fig 4.59 : Optical micrographs for Ag CdO (C) samples

Fig 4.60 : Optical micrographs for Ag ZnO (E) samples

Fig 4.61 : Optical micrographs for Ag CdO (E) samples

Fig 4.62 : Optical micrographs for Ag ZnO (F) samples

Fig 4.63 : Optical micrographs for Ag CdO (F) samples

Fig 4.64 : Optical micrographs for Ag ZnO (MA) and Ag CdO (MA) samples

Fig 4.65 : Histograms showing % area fraction for ZnO in Ag ZnO compacts for different process routes

Fig 4.66 : Histograms showing % area fraction for CdO in Ag CdO compacts for different process routes

Fig 4.67 : Histograms showing roundness factor for ZnO phase for different process routes

Fig 4.68 : Histograms showing roundness factor for CdO phase for different process routes

Fig 4.69 : Histograms showing feret average for ZnO particles for different process routes

Fig 4.70 : Histograms showing feret average for CdO particles for different process routes

Fig 4.71 : Multiple plots for percentage undersize versus particle size in microns for Li-treated and Li free Ag 10.8 ZnO powder samples.

Fig 4.72 : ESCA profile for Li-treated Ag 10.8 ZnO powder sample

Fig 4.73 : Optical micrographs for Ag 10.8 ZnO final hot-pressed compacts
(a) without Li addition and (b) with 1% LiNO_3 addition

Fig 4.74 : Variation of contact erosion with make and break operations for

Ag 7.1 ZnO (C), Ag 7.1 ZnO (E) and Ag 10CdO (B) contacts

Fig 4.75 : Variation of contact resistance with make and break operations for

Ag 7.1 ZnO (C), Ag 7.1 ZnO (E) and Ag 10CdO (B) contacts

Fig 4.76 : Variation of contact erosion with make and break operations for Ag 8.6 –

ZnO (C) and Ag 8.6 ZnO (E) contacts

Fig 4.77 : Variation of contact resistance with make and break operations for Ag 8.6 –

ZnO (C) and Ag 8.6 ZnO (E) contacts

Fig 4.78 : Histograms showing temperature rise for Ag 8.6 ZnO (C) and Ag 8.6 –

ZnO (E) contacts at different time intervals

Fig 4.79 : Variation of contact erosion with make and break operations for

Ag 10.8 ZnO (C) and Ag 10.8 ZnO (E) contacts

Fig 4.80 : Variation of contact resistance with make and break operations for

Ag 10.8 ZnO (C) and Ag 10.8 ZnO (E) contacts

Fig 4.81 : Variation of contact erosion with make and break operations for

Ag 10.8 ZnO (MA) and Ag 15CdO (MA) contacts in DC mode

Fig 4.82 : Variation of contact resistance with make and break operations for

Ag 10.8 ZnO (MA) and Ag 15CdO (MA) contacts in DC mode