DECLARATION OF JUNE ANN MUNFORD

APPLE 1029

1. My name is June Ann Munford. I am over the age of 18, have personal knowledge of the facts set forth herein, and am competent to testify to the same.

2. I earned a Master of Library and Information Science (MLIS) from the University of Wisconsin-Milwaukee in 2009. I have over ten years of experience in the library/information science field. Beginning in 2004, I have served in various positions in the public library sector including Assistant Librarian, Youth Services Librarian and Library Director. I have attached my Curriculum Vitae as Appendix CV.

3. During my career in the library profession, I have been responsible for materials acquisition for multiple libraries. In that position, I have cataloged, purchased and processed incoming library works. That includes purchasing materials directly from vendors, recording publishing data from the material in question, creating detailed material records for library catalogs and physically preparing that material for circulation. In addition to my experience in acquisitions, I was also responsible for analyzing large collections of library materials, tailoring library records for optimal catalog

search performance and creating lending agreements between libraries during my time as a Library Director.

4. I am fully familiar with the catalog record creation process in the library sector. In preparing a material for public availability, a library catalog record describing that material would be created. These records are typically written in Machine Readable Catalog (herein referred to as "MARC") code and contain information such as a physical description of the material, metadata from the material's publisher, and date of library acquisition. In particular, the 008 field of the MARC record is reserved for denoting the date of creation of the library record itself. As this typically occurs during the process of preparing materials for public access, it is my experience that an item's MARC record indicates the date of an item's public availability.

5. Typically, in creating a MARC record, a librarian would gather various bits of metadata such as book title, publisher and subject headings among others and assign each value to a relevant numerical field. For example, a book's physical description is tracked in field 300 while title/attribution is tracked in field 245. The 008 field of the MARC record is reserved for denoting the creation of the library record itself. As this is the only date reflecting the inclusion of said materials within the library's collection, it is my experience

that an item’s 008 field accurately indicates the date of an item’s public availability.

6. I have reviewed Exhibit APPLE-1008, "Integrated Electrochemical Deposition of Copper Metallization for Ultralarge-Scale Integrated Circuits" by Shou-Yi Chang, et al as published in Journal of the Electrochemical Society January 2004.

7. Attached hereto as Appendix CHANG01 is a true and correct copy of the MARC record for Journal of the Electrochemical Society as held by the Penn State University Library. I secured this record myself from the library’s public catalog. The MARC record contained within Appendix CHANG01 accurately describes the title, publisher and ISSN number of Journal of the Electrochemical Society. The Availability field present on page 11 of this record indicates the library's collection includes the January 2004 issue of Journal of the Electrochemical Society containing "Integrated Electrochemical Deposition of Copper Metallization for Ultralarge-Scale Integrated Circuits".

8. Attached hereto as Appendix CHANG02 is a true and correct copy of "Integrated Electrochemical Deposition of Copper Metallization for

Ultralarge-Scale Integrated Circuits" as published in Journal of the Electrochemical Society as held by the Penn State University Library. These scans were secured from the library's collection. In comparing Exhibit 1008 to Appendix CHANG02, it is my determination that Exhibit 1008 is a true and correct copy of "Integrated Electrochemical Deposition of Copper Metallization for Ultralarge-Scale Integrated Circuits" by Shou-Yi Chang, et al as published in Journal of the Electrochemical Society.

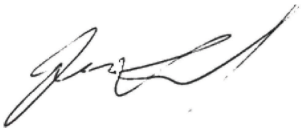
9. The 008 field of the MARC record in Appendix CHANG01 indicates the date of record creation. The 008 field of Appendix CHANG01 indicates the Penn State University Library first acquired Journal of the Electrochemical Society as of October 3, 1974 and held the journal in perpetuity until the publication of "Integrated Electrochemical Deposition of Copper Metallization for Ultralarge-Scale Integrated Circuits". Considering this information, it is my determination that Journal of the Electrochemical Society January 2004 and therefore "Integrated Electrochemical Deposition of Copper Metallization for Ultralarge-Scale Integrated Circuits" was made available to the public shortly after its initial publication in January 2004.

10. I have been retained on behalf of the Petitioner to provide assistance in the above-illustrated matter in establishing the authenticity and public

availability of the documents discussed in this declaration. I am being compensated for my services in this matter at the rate of $200.00 per hour plus reasonable expenses. My statements are objective, and my compensation does not depend on the outcome of this matter.

11. I declare under penalty of perjury that the foregoing is true and correct. I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code.

Dated: 2/5/2024



June Ann Munford

APPENDIX CV

June A. Munford
Curriculum Vitae

Education

University of Wisconsin-Milwaukee - MS, Library & Information Science, 2009
Milwaukee, WI

- Coursework included cataloging, metadata, data analysis, library systems, management strategies and collection development.
- Specialized in library advocacy, cataloging and public administration.

Grand Valley State University - BA, English Language & Literature, 2008
Allendale, MI

- Coursework included linguistics, documentation and literary analysis.
- Minor in political science with a focus in local-level economics and government.

Professional Experience

Researcher / Expert Witness, October 2017 – present
Freelance ● Pittsburgh, Pennsylvania & Grand Rapids, Michigan

- Material authentication and public accessibility determination. Declarations of authenticity and/or public accessibility provided upon research completion. Experienced with appeals and deposition process.

- Research provided on topics of public library operations, material publication history, digital database services and legacy web resources.

- Past clients include Alston & Bird, Arnold & Porter, Baker Botts, Fish & Richardson, Erise IP, Irell & Manella, O'Melveny & Myers, Perkins-Coie, Pillsbury Winthrop Shaw Pittman and Slayden Grubert Beard.

Library Director, February 2013 - March 2015
Dowagiac District Library ● Dowagiac, Michigan

- Executive administrator of the Dowagiac District Library. Located in

Southwest Michigan, this library has a service area of 13,000, an annual operating budget of over $400,000 and total assets of approximately $1,300,000.

● Developed careful budgeting guidelines to produce a 15% surplus during the 2013-2014 & 2014-2015 fiscal years while being audited.

● Using this budget surplus, oversaw significant library investments including the purchase of property for a future building site, demolition of existing buildings and building renovation projects on the current facility.

● Led the organization and digitization of the library's archival records.

● Served as the public representative for the library, developing business relationships with local school, museum and tribal government entities.

● Developed an objective-based analysis system for measuring library services - including a full collection analysis of the library's 50,000+ circulating items and their records.

November 2010 - January 2013
Librarian & Branch Manager, Anchorage Public Library ● Anchorage, Alaska

● Headed the 2013 Anchorage Reads community reading campaign including event planning, staging public performances and creating marketing materials for mass distribution.

● Co-led the social media department of the library's marketing team, drafting social media guidelines, creating original content and instituting long-term planning via content calendars.

● Developed business relationships with The Boys & Girls Club, Anchorage School District and the US Army to establish summer reading programs for children.

June 2004 - September 2005, September 2006 - October 2013
Library Assistant, Hart Area Public Library
Hart, MI

● Responsible for verifying imported MARC records and original MARC

cataloging for the local-level collection as well as the Michigan Electronic Library.

● Handled OCLC Worldcat interlibrary loan requests & fulfillment via ongoing communication with lending libraries.

Professional Involvement

Alaska Library Association - Anchorage Chapter
- Treasurer, 2012

Library Of Michigan
- Level VII Certification, 2008
- Level II Certification, 2013

Michigan Library Association Annual Conference 2014
- New Directors Conference Panel Member

Southwest Michigan Library Cooperative
- Represented the Dowagiac District Library, 2013-2015

Professional Development

Library Of Michigan Beginning Workshop, May 2008
Petoskey, MI
- Received training in cataloging, local history, collection management, children's literacy and reference service.

Public Library Association Intensive Library Management Training, October 2011
Nashville, TN
- Attended a five-day workshop focused on strategic planning, staff management, statistical analysis, collections and cataloging theory.

Alaska Library Association Annual Conference 2012 - Fairbanks, February 2012
Fairbanks, AK
- Attended seminars on EBSCO advanced search methods, budgeting, cataloging, database usage and marketing.

Depositions

2019 ● Fish & Richardson

Apple v. Qualcomm (IPR2018-001281, 39521-00421IP, IPR2018-01282 and 39521-00421IP2)

2019 ● Erise IP

Implicit, LLC v. Netscout Systems, Inc (Civil Action No. 2:18-cv-53-JRG)

2019 ● Perkins-Coie

Adobe Inc. v. RAH Color Technologies LLC (Cases IPR2019-00627, IPR2019-00628, IPR2019-00629 and IPR2019-00646)

2020 ● O'Melveny & Myers

Maxell, Ltd. v. Apple Inc. (Case No. 5:19-cv-00036-RWS)

2021 ● Pillsbury Winthrop Shaw Pittman LLP

Intel v. SRC (IPR2020-1449)

2022 ● Perkins-Coie

Realtek v. Future Link (IPR2021-01182)

2023 ● Fish & Richardson

Neuroderm Ltd. v. Abbvie, Inc (Case No. PGR2022-00040)

2023 ● Fish & Richardson

Nearmap US Inc. v. Pictometry International Corp. (IPR2022-00735)

2023 ● Fish & Richardson

Samsung Electronics v. MemoryWeb LLC (Case No. 39843-0136PS1)

2023 ● Pillsbury Winthrop Shaw Whitman LLP

Gravel Rating Systems v. Costco Wholesale Corp. (Civil Action No. 4:21-cv-149-ALM)

2024 ● Willkie-Farr

Netflix, Inc. v. VideoLabs. Inc. (IPR2023-00628)

Limited Case and Clientele History

Alston & Bird

- Ericsson

  v. Collision Communications (IPR2022-01233)

- Nokia

  v. Neptune Subsea, Xtera (Case No. 1:17-cv-01876)

- Universal Electronics Inc

  v. Roku Inc (IPR2022-00818)

Arnold & Porter

- Ivantis

  v. Glaukos (Case No. 8:18-cv-00620)

- Samsung

  v. Jawbone (Case No. 2:21-cv-00186)

Benesch Friedlander Coplan & Aronoff

- Voyis

  v. Cathx (Case No. 5:21-cv-00077-RWS)

Deschert LLP

- Smaxtec Animal Care

  v. ST Reproductive Technologies, LLC (IPR2024-00885)

Erise I.P.

- Apple

  v. Ericsson Inc. (IPR2022-00715)

  v. Future Link Systems (IPRs 6317804, 6622108, 6807505, and 7917680)

  v. INVT (Case No. 20-1881)

  v. Navblazer LLC (IPR2020-01253)

  v. Qualcomm (IPR2018-001281, 39521-00421IP, IPR2018-01282, 39521-00421IP2)

  v. Quest Nettech Corp (Case No. 2:19-cv-00118-JRG)

  v. Telefonaktiebolaget LM Ericsson (IPR2022-00275)

  v. Theta IP, LLC (IPR2024-00818)

- Fanduel

  v. CGT (Case No. 19-1393)

- Garmin

  v. Phillips North America LLC (Case No. 2:19-cv-6301-AB-KS)

- Netscout
    - v. Longhorn HD LLC (Case No. 2:20-cv-00349)
    - v. Implicit, LLC (Civil Action No. 2:18-cv-53-JRG)

- Sony Interactive Entertainment LLC
    - v. Bot M8 LLC (IPR2020-01288)
    - v. Infernal Technology LLC (Case No. 2:19-CV-00248-JRG)

- Unified Patents
    - v. GE Video Compression (Civil Action No. 2:19-cv-248)

Fish & Richardson

- Apple
    - v. AliveCor (3:21-cv-03958)
    - v. LBS Innovations (Case No. 2:19-cv-00119-JRG-RSP)
    - v. Koss Corporation (IPR2021-00305)
    - v. Masimo (IPR 50095-0012IP1, 50095-0012IP2, 50095-0013IP1, 50095-0013IP2, 50095-0006IP1, 50095-0135IP1)
    - v. Neonode (Case No. 21-cv-08872-EMC)
    - v. Qualcomm (IPR2018-001281, 39521-00421IP, IPR2018-01282, 39521-00421IP2)

- Dell
    - v. Neo Wireless (IPR2022-00616)

- Dish Network
    - v. Entropic Communications, LLC (Case No. 2:2023-CV-01043)

v. Realtime Adaptive Streaming (Case No. 1:17-CV-02097-RBJ)

v. TQ Delta LLC (Case No. 18-1798)

- Evapco Dry Cooling

  v. SPG Dry Cooling (IPR2021-00688)

- Genetec

  v. Sensormatic Electronics (Case No. 1:20-CV-00760)

- Huawei

  v. Bell Northern Research LLC (IPR2019-01174)

- Kianxis

  v. Blue Yonder (Case No. 3:20-cv-03636)

- LG Electronics

  v. Bell Northern Research LLC (Case No. 3:18-cv-2864-CAB-BLM)

- Metaswitch

  v. Sonus Networks (IPR2018-01719)

- Microsoft

  v. Throughputer Inc (IPR2022-00757)

- Mom Enterprises

  v. Ddrops Company (Case No. 1:22-cv-00332)

- MLC Intellectual Property

v. MicronTech (Case No. 3:14-cv-03657-SI)

- Nearmap Inc
  - v. EagleView Technologies (IPR2022-01009)

- Neuroderm Ltd.
  - v. Abbvie, Inc (Case No. PGR2022-00040)

- Realtek Semiconductor
  - v. Future Link (IPR2021-01182)

- Quectel
  - v. Koninklijke Philips (Case No. 1:20-cv-01710)

- Samsung
  - v. Aire Technology (IPR2022-00877)
  - v. Bell Northern Research (Case No. 2:19-cv-00286-JRG)
  - v. Communication Technologies Inc (IPR2022-01221)
  - v. Jawbone Innovations (IPR2022-00865)
  - v. MemoryWeb LLC (IPR2022-00885)
  - v. Dodots Licensing Solutions (IPR2023-00701)
  - v. Telefonaktiebolaget LM Ericsson (IPR2021-00615)

- Texas Instruments
  - v. Vantage Micro LLC (IPR2020-01261)

- Xilinx
  - v. Sentient Sensors LCC (Case No. 1:22-cv-00173)

Groombridge Wu

- Nearmap

  v. Eagle View Technologies Inc. and Pictometry International Corp. (Case No. 2:21-cv-00283-TS-DAO)

Irell & Manella

- Curium

O'Melveny & Myers

- Apple

  v. Maxell (Case No. 5:19-cv-00036-RWS)

- Disney Media & Entertainment Distribution LLC

  v. Digital Media Technology Holdings, LLC (Case No. 2:22-cv-01642)

- Micron Technology Inc.

  v. Besang Inc (IPR2023-00900)

- Samsung

  v. Daedalus Prime LLC (1335 Investigation)

Perkins-Coie

- Amazon

  v. Nokia (IPR2024-00847 and IPR2024-00848)

- Heru Industries
    - v. The UAB Research Foundation (IPR2022-01148)
- Intel Corporation
    - v. BeSang Inc. (IPR2023-00991)
    - v. BitMICRO (Case No. 5:23-cv-00625)
    - v. Telefonaktiebolaget L M Ericsson (IPR2024-00610)
- Realtek Semiconductor
    - v. Future Link (IPR2021-01182)
- Twitter Inc
    - v. VOIP-Pal.com (Case No. 3:20-cv-02397-JD)
- TCL Industries
    - v. Koninklijke Philips NV (IPR2021-00495, IPR2021-00496 and IPR2021-00497)

Pillsbury Winthrop Shaw Pittman

- Intel
    - v. FG SRC LLC (Case No. 6:20-cv-00315)
- Gravel Rating Systems
    - v. Costco (Case No. 4:21-cv-149)
    - v. Lowe's Home Centers (Case No. 4:21-cv-150)
    - v. T-Mobile USA (Case No. 4:21-cv-152)
    - v. Kohl's Inc. (Case No. 4:21-cv-258)
    - v. Under Armor (Case No. 4:21-cv-356)

Quinn Emanuel

- ServiceNow, Inc.

  v. InQuisient, Inc. (Case No. 22-900-CJB)

- Wolfspeed

  v. The Trustees of Purdue University (Case No. 1:2021-cv-00840)

Sheppard, Mullin, Richter & Hampton LLP

- Cadence Design Systems Inc.

  v. Semiconductor Design Technologies (Case No. 3:23-cv-01001)

Stern, Kessler, Goldstein & Fox

- Preliminary Research

Willkie, Farr & Gallagher LLP

- Neurent

  v. The Foundry, LLC (IPR2024-00669)

- Netflix, Inc.

  v. VideoLabs, Inc. (IPR2023-00628)

APPENDIX CHANG01

PennState University Libraries | Catalog

Bookmarks 0 Course Reserves My Account

Keyword Search... Search Advanced search Start Over

Share Bookmark Report an Issue

MARC View

LEADER 44500nas a2204453 a 4500				
001 1376697				
003 SIRSI				
005 20160707134118.0				
008 741003c19489999njumr p 0 a0eng				
010				a| 48010635 z| sn 80002310
016	7			a| J19740000 2| DNLM
019				a| 1567736 a| 185061333 a| 219835009 a| 220821592 a| 230707163
019				a| MARS
022	0			a| 0013-4651 2| 1
030				a| JESOAN
032				a| 284140 b| USPS
035				a| (OCoLC)1029376
040				a| NLM c| NLM d| NSD d| IUL d| NSD d| DLC d| NSD d| IUL d| SER d| RCS d| AIP d| DLC d| AIP d| DLC d| OCL d| AIP d| DLC d| NSD d| OCL d| NST d| NSD d| OCL d| NSD d| NST d| OCL d| NST d| OCL d| NST d| FUG d| AGL d| DLC d| MYG d| OCLCQ d| HNK d| IXA d| NLGGC d| LVB d| GUA d| NSD d| UtOrBLW
042				a| nsdp a| lc
050	0		0	a| TP250 b| .E542
060	0		0	a| W1 JO92K
070	0			a| 381 b| El22J
072			0	a| X600
072			0	a| X500
082	0			a| 541.3705
210	0			a| J. Electrochem. Soc.
222			0	a| Journal of the Electrochemical Society
245	0		0	a| Journal of the Electrochemical Society.
264			1	a| New York, N.Y. : b| Electrochemical Society, c| 1948-
300				a| volumes : b| illustrations, portraits ; c| 23-29 cm
310				a| Monthly
336				a| text b| txt 2| rdacontent
337				a| unmediated b| n 2| rdamedia
338				a| volume b| nc 2| rdacarrier
362	0			a| Vol. 93, no. 1 (Jan. 1948)-
500				a| Title from cover.
500				a| Published: Manchester, NH, <1980->; Pennington, NJ, <2004->
500				a| Latest issue consulted: Vol. 156, no. 1 (2009).
510	2			a| Chemical abstracts x| 0009-2258
530				a| Also available in CD-ROM version.
530				a| Also issued online.
555				a| Vols. 93 (1948)-98 (1951), (Includes index to its Transactions. v. 81 (1942)-92 (1947), 1 v.; Vols. 99 (1952)-108 (1961), 1 v.; Vols. 109 (1962)-118 (1971). 1 v.
580				a| Formed by the union of: Bulletin of the Electrochemical Society, and: Preprint - Electrochemical Society and continues the vol. numbering of the latter.
580				a| Absorbed in 1950: Transactions of the Electrochemical Society.
650			2	a| Chemistry.
650			2	a| Electronics.
650			0	a| Electrochemistry v| Periodicals.
650			0	a| Electrochemistry x| Societies, etc.
655			2	a| Periodicals.
710	2			a| Electrochemical Society.
776	1			t| Electrochemical Society : [journals] w| (DLC) 2005240637 w| (OCoLC)53880414
776	1			t| Journal of the Electrochemical Society (Online) x| 1945-7111 w| (DLC) 2007233941 w| (OCoLC)60639352
780	1	4		t| Bulletin of the Electrochemical Society x| 0898-1388 w| (OCoLC)9067993
780	1	4		a| Electrochemical Society. t| Preprint - Electrochemical Society x| 0898-1396 w| (OCoLC)6369869

ASK A LIBRARIAN

780 1 5 t| Transactions of the Electrochemical Society g| 1950 x| 0096-4743 w| (DLC) 02023913 w| (OCoLC)1567737

785 0 1 t| Electrochemical Society interface x| 1064-8208 w| (DLC) 94660502 w| (OCoLC)26409155

949 a| Periodical w| ASIS c| 1 i| 1376697-2001 d| 9/30/1999 l| PERIOD-HB m| HARRISBURG r| Y s| Y t| PERIODICAL u| 4/13/2001

949 a| TP250.E542 v.112 no.1-6 1965 w| LCPER c| 1 i| 000060017284 d| 9/30/1999 l| ACAD-BLDG m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 4/13/2001

949 a| TP250.E542 v.142 no.1-2 1995 w| LCPER c| 1 i| 000048070010 d| 3/2/2021 l| BDJNL-PM m| UP-PAMS q| 1 r| Y s| Y t| PERIODICAL u| 8/8/2001

949 a| TP250.E542 v.142 no.3-4 1995 w| LCPER c| 1 i| 000048070027 l| BDJNL-PM m| UP-PAMS r| Y s| Y t| PERIODICAL u| 8/8/2001

949 a| TP250.E542 v.142 no.5-6 1995 w| LCPER c| 1 i| 000048070034 d| 10/1/2002 e| 10/1/2002 l| BDJNL-PM m| UP-PAMS n| 1 r| Y s| Y t| PERIODICAL u| 8/8/2001

949 a| TP250.E542 v.142 no.9-10 1995 w| LCPER c| 1 i| 000048070041 d| 6/16/2005 e| 6/16/2005 l| BDJNL-PM m| UP-PAMS n| 1 r| Y s| Y t| PERIODICAL u| 8/8/2001

949 a| TP250.E542 v.142 no.11-12 1995 w| LCPER c| 1 i| 000048070058 l| BDJNL-PM m| UP-PAMS r| Y s| Y t| PERIODICAL u| 8/8/2001

949 a| TP250.E542 v.143 no.1-2 1996 w| LCPER c| 1 i| 000048052412 d| 6/7/2005 e| 6/7/2005 l| BDJNL-PM m| UP-PAMS n| 1 r| Y s| Y t| PERIODICAL u| 8/8/2001

949 a| TP250.E542 v.143 no.3-4 1996 w| LCPER c| 1 i| 000048052429 l| BDJNL-PM m| UP-PAMS r| Y s| Y t| PERIODICAL u| 8/8/2001

949 a| TP250.E542 v.143 no.5-6 1996 w| LCPER c| 1 i| 000048052436 d| 8/27/2003 e| 8/27/2003 l| BDJNL-PM m| UP-PAMS n| 1 r| Y s| Y t| PERIODICAL u| 8/8/2001

949 a| TP250.E542 v.143 no.7-8 1996 w| LCPER c| 1 i| 000048052443 l| BDJNL-PM m| UP-PAMS r| Y s| Y t| PERIODICAL u| 8/8/2001

949 a| TP250.E542 v.143 no.9-10 1996 w| LCPER c| 1 i| 000048052450 l| BDJNL-PM m| UP-PAMS r| Y s| Y t| PERIODICAL u| 8/8/2001

949 a| TP250.E542 v.143 no.11-12 1996 w| LCPER c| 1 i| 000048052467 l| BDJNL-PM m| UP-PAMS r| Y s| Y t| PERIODICAL u| 8/8/2001

949 a| TP250.E542 v.144 no.1-2 1997 w| LCPER c| 1 i| 000048052474 l| BDJNL-PM m| UP-PAMS r| Y s| Y t| PERIODICAL u| 8/8/2001

949 a| TP250.E542 v.144 no.3-4 1997 w| LCPER c| 1 i| 000048052481 d| 4/5/2002 e| 4/5/2002 l| BDJNL-PM m| UP-PAMS n| 1 r| Y s| Y t| PERIODICAL u| 8/8/2001

949 a| TP250.E542 v.144 no.5-6 1997 w| LCPER c| 1 i| 000048052498 d| 11/16/2004 e| 11/16/2004 l| BDJNL-PM m| UP-PAMS n| 1 r| Y s| Y t| PERIODICAL u| 8/8/2001

949 a| TP250.E542 v.144 no.7-8 1997 w| LCPER c| 1 i| 000048052504 l| BDJNL-PM m| UP-PAMS r| Y s| Y t| PERIODICAL u| 8/8/2001

949 a| TP250.E542 v.144 no.9-10 1997 w| LCPER c| 1 i| 000048052511 l| BDJNL-PM m| UP-PAMS r| Y s| Y t| PERIODICAL u| 8/8/2001

949 a| TP250.E542 v.144 no.11-12 1997 w| LCPER c| 1 i| 000048052528 d| 11/16/2004 e| 11/16/2004 l| BDJNL-PM m| UP-PAMS n| 1 r| Y s| Y t| PERIODICAL u| 8/8/2001

949 a| TP250.E542 v.145 no.1-2 1998 w| LCPER c| 1 i| 000048052535 l| BDJNL-PM m| UP-PAMS r| Y s| Y t| PERIODICAL u| 8/8/2001

949 a| TP250.E542 v.145 no.3-4 1998 w| LCPER c| 1 i| 000048052542 d| 12/18/2001 e| 12/18/2001 l| BDJNL-PM m| UP-PAMS n| 1 r| Y s| Y t| PERIODICAL u| 8/8/2001

949 a| TP250.E542 v.145 no.5-6 1998 w| LCPER c| 1 i| 000048052559 l| BDJNL-PM m| UP-PAMS r| Y s| Y t| PERIODICAL u| 8/8/2001

949 a| TP250.E542 v.145 no.7-8 1998 w| LCPER c| 1 i| 000048052566 l| BDJNL-PM m| UP-PAMS r| Y s| Y t| PERIODICAL u| 8/8/2001

949 a| TP250.E542 v.145 no.9-10 1998 w| LCPER c| 1 i| 000048052573 l| BDJNL-PM m| UP-PAMS r| Y s| Y t| PERIODICAL u| 8/8/2001

949 a| TP250.E542 v.142 no.7-8 1995 w| LCPER c| 1 i| 000045118869 l| BDJNL-PM m| UP-PAMS r| Y s| Y t| PERIODICAL u| 11/6/2001

949 a| TP250.E542 v.150 no.11 2003 w| LCPER c| 1 i| 000052783401 l| CATO-PARK m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 1/29/2004

949 a| TP250.E542 v.150 no.10 2003 w| LCPER c| 1 i| 000052783418 l| CATO-PARK m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 1/29/2004

949 a| TP250.E542 v.150 no.9 2003 w| LCPER c| 1 i| 000052567889 l| CATO-PARK m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 10/13/2003

949 a| TP250.E542 v.150 no.8 2003 w| LCPER c| 1 i| 000052567872 l| CATO-PARK m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 10/13/2003

949 a| TP250.E542 v.150 no.7 2003 w| LCPER c| 1 i| 000052567865 l| CATO-PARK m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 10/13/2003

949 a| TP250.E542 v.150 no.6 2003 w| LCPER c| 1 i| 000052524271 l| CATO-PARK m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 7/28/2003

949 a| TP250.E542 v.150 no.5 2003 w| LCPER c| 1 i| 000052525056 l| CATO-PARK m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 7/28/2003

949 a| TP250.E542 v.150 no.4 2003 w| LCPER c| 1 i| 000052524240 l| CATO-PARK m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 7/28/2003

949 a| TP250.E542 v.150 no.3 2003 w| LCPER c| 1 i| 000052524264 l| CATO-PARK m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 7/28/2003

949 a| TP250.E542 v.150 no.2 2003 w| LCPER c| 1 i| 000052538728 l| CATO-PARK m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 8/22/2003

949 a| TP250.E542 v.150 no.1 2003 w| LCPER c| 1 i| 000052524257 l| CATO-PARK m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 7/28/2003

949 a| TP250.E542 v.149 no.11-12 2002 w| LCPER c| 1 i| 000052491504 l| CATO-PARK m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 5/30/2003

949 a| TP250.E542 v.149 no.9-10 2002 w| LCPER c| 1 i| 000052491498 l| CATO-PARK m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 5/30/2003

949 a| TP250.E542 v.149 no.7-8 2002 w| LCPER c| 1 i| 000051743475 l| CATO-PARK m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 1/2/2003

949 a| TP250.E542 v.149 no.5-6 2002 w| LCPER c| 1 i| 000051743468 l| CATO-PARK m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 1/2/2003

949 a| TP250.E542 v.149 no.3-4 2002 w| LCPER c| 1 i| 000051743499 l| CATO-PARK m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 1/2/2003

949 a| TP250.E542 v.149 no.1-2 2002 w| LCPER c| 1 i| 000051743482 l| CATO-PARK m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 1/2/2003

949 a| TP250.E542 v.148 no.11-12 2001 w| LCPER c| 1 i| 000048391917 l| CATO-PARK m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 6/27/2002

949 a| TP250.E542 v.148 no.9-10 2001 w| LCPER c| 1 i| 000048391900 l| CATO-PARK m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 6/27/2002

949 a| TP250.E542 v.148 no.7-8 2001 w| LCPER c| 1 i| 000048293754 l| CATO-PARK m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 4/3/2002

949 a| TP250.E542 v.148 no.5-6 2001 w| LCPER c| 1 i| 000048293747 l| CATO-PARK m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 4/3/2002

949 a| TP250.E542 v.148 no.3-4 2001 w| LC c| 1 i| 000047629493 d| 12/11/2001 e| 12/11/2001 l| CATO-PARK m| UP-ANNEX n| 2 r| Y s| Y t| PERIODICAL u| 8/8/2001

949 a| TP250.E542 v.148 no.1-2 2001 w| LCPER c| 1 i| 000047629486 d| 9/30/1999 l| CATO-PARK m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 4/13/2001

949 a| TP250.E542 v.147 no.11-12 2000 w| LCPER c| 1 i| 000047199378 l| CATO-PARK m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 11/12/2001

949 a| TP250.E542 v.147 no.9-10 2000 w| LCPER c| 1 i| 000047199293 l| CATO-PARK m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 11/12/2001

949 a| TP250.E542 v.147 no.7-8 2000 w| LCPER c| 1 i| 000048052689 l| CATO-PARK m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 8/8/2001

949 a| TP250.E542 v.147 no.5-6 2000 w| LCPER c| 1 i| 000048052672 d| 12/11/2001 e| 12/11/2001 l| CATO-PARK m| UP-ANNEX n| 2 r| Y s| Y t| PERIODICAL u| 8/8/2001

949 a| TP250.E542 v.147 no.3-4 2000 w| LCPER c| 1 i| 000048052665 l| CATO-PARK m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 8/8/2001

949 a| TP250.E542 v.147 no.1-2 2000 w| LCPER c| 1 i| 000048052658 l| CATO-PARK m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 8/8/2001

949 a| TP250.E542 v.146 no.11-12 1999 w| LCPER c| 1 i| 000048052641 d| 11/1/2001 e| 11/1/2001 l| CATO-PARK m| UP-ANNEX n| 1 r| Y s| Y t| PERIODICAL u| 8/8/2001

949 a| TP250.E542 v.146 no.9-10 1999 w| LCPER c| 1 i| 000048052634 l| CATO-PARK m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 8/8/2001

949 a| TP250.E542 v.146 no.7-8 1999 w| LCPER c| 1 i| 000048052627 l| CATO-PARK m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 8/8/2001

949 a| TP250.E542 v.146 no.5-6 1999 w| LCPER c| 1 i| 000048052610 l| CATO-PARK m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 8/8/2001

949 a| TP250.E542 v.146 no.3-4 1999 w| LCPER c| 1 i| 000048052603 l| CATO-PARK m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 8/8/2001

949 a| TP250.E542 v.146 no.1-2 1999 w| LCPER c| 1 i| 000048052597 l| CATO-PARK m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 8/8/2001

949 a| TP250.E542 v.127 no.10-12 1980 w| LCPER c| 1 i| 000048051835 l| CATO-PARK m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 8/8/2001

949 a| TP250.E542 v.127 no.9-12 1980 w| LCPER c| 1 i| 000048051828 d| 9/12/2005 e| 4/29/2005 l| CATO-PARK m| UP-ANNEX n| 1 q| 2 r| Y s| Y t| PERIODICAL u| 8/8/2001

949 a| TP250.E542 v.127 no.7-8 1980 w| LCPER c| 1 i| 000048051811 l| CATO-PARK m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 8/8/2001

949 a| TP250.E542 v.127 no.4-6 1980 w| LCPER c| 1 i| 000048051804 d| 9/20/2005 l| CATO-PARK m| UP-ANNEX q| 1 r| Y s| Y t| PERIODICAL u| 8/8/2001

949 a| TP250.E542 v.127 no.1-3 1980 w| LC c| 1 i| 000045119385 d| 3/18/2005 e| 3/17/2005 l| CATO-PARK m| UP-ANNEX n| 1 r| Y s| Y t| PERIODICAL u| 11/6/2001

949 a| TP250.E542 v.126 no.10-12 1979 w| LCPER c| 1 i| 000048051798 d| 9/30/2004 l| CATO-PARK m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 8/8/2001

949 a| TP250.E542 v.126 no.7-9 1979 w| LCPER c| 1 i| 000048051781 d| 11/22/2005 l| CATO-PARK m| UP-ANNEX q| 1 r| Y s| Y t| PERIODICAL u| 8/8/2001

949 a| TP250.E542 v.126 no.4-6 1979 w| LCPER c| 1 i| 000048051774 d| 1/26/2006 l| CATO-PARK m| UP-ANNEX q| 3 r| Y s| Y t| PERIODICAL u| 8/8/2001

949 a| TP250.E542 v.126 no.1-3 1979 w| LCPER c| 1 i| 000048051767 d| 4/3/2007 e| 9/23/2004 l| CATO-PARK m| UP-ANNEX n| 1 q| 3 r| Y s| Y t| PERIODICAL u| 8/8/2001

949 a| TP250.E542 v.125 no.8-10 1978 w| LCPER c| 1 i| 000048051743 l| CATO-PARK m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 8/8/2001

949 a| TP250.E542 v.125 no.7-12 1978 w| LCPER c| 1 i| 000048051750 d| 10/31/2005 l| CATO-PARK m| UP-ANNEX q| 1 r| Y s| Y t| PERIODICAL u| 8/8/2001

949 a| TP250.E542 v.125 no.4-7 1978 w| LCPER c| 1 i| 000048051736 d| 9/26/2005 e| 3/17/2005 l| CATO-PARK m| UP-ANNEX n| 1 q| 2 r| Y s| Y t| PERIODICAL u| 8/8/2001

949 a| TP250.E542 v.125 no.1-3 1978 w| LCPER c| 1 i| 000048051729 l| CATO-PARK m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 8/8/2001

949 a| TP250.E542 v.124 no.9-12 1977 w| LCPER c| 1 i| 000048051712 d| 5/10/2006 e| 7/13/2004 l| CATO-PARK m| UP-ANNEX n| 1 q| 2 r| Y s| Y t| PERIODICAL u| 8/8/2001

949 a| TP250.E542 v.124 no.5-8 1977 w| LCPER c| 1 i| 000048051705 d| 4/3/2007 e| 3/17/2005 l| CATO-PARK m| UP-ANNEX n| 1 q| 1 r| Y s| Y t| PERIODICAL u| 8/8/2001

949 a| TP250.E542 v.124 no.1-4 1977 w| LCPER c| 1 i| 000048051699 l| CATO-PARK m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 8/8/2001

949 a| TP250.E542 v.123 no.9-12 1976 w| LCPER c| 1 i| 000048051682 d| 1/25/2006 e| 3/17/2005 l| CATO-PARK m| UP-ANNEX n| 1 q| 3 r| Y s| Y t| PERIODICAL u| 8/8/2001

949 a| TP250.E542 v.123 no.5-8 1976 w| LCPER c| 1 i| 000048051675 d| 6/8/2005 l| CATO-PARK m| UP-ANNEX q| 1 r| Y s| Y t| PERIODICAL u| 8/8/2001

949 a| TP250.E542 v.123 no.1-6 1976 w| LCPER c| 1 i| 000048051651 d| 8/19/2005 l| CATO-PARK m| UP-ANNEX q| 1 r| Y s| Y t| PERIODICAL u| 8/8/2001

949 a| TP250.E542 v.123 no.1-4 1976 w| LCPER c| 1 i| 000048051668 d| 5/15/2006 e| 7/13/2004 l| CATO-PARK m| UP-ANNEX n| 1 q| 2 r| Y s| Y t| PERIODICAL u| 8/8/2001

949 a| TP250.E542 v.122 July-Dec.1975 w| LC c| 1 i| 000045119378 d| 8/9/2006 l| CATO-PARK m| UP-ANNEX q| 2 r| Y s| Y t| PERIODICAL u| 11/6/2001

949 a| TP250.E542 v.122 Jan.-June 1975 w| LCPER c| 1 i| 000048051644 d| 11/28/2005 l| CATO-PARK m| UP-ANNEX q| 4 r| Y s| Y t| PERIODICAL u| 8/8/2001

949 a| TP250.E542 v.121 July-Dec.1974 w| LCPER c| 1 i| 000048051637 d| 6/12/2007 l| CATO-PARK m| UP-ANNEX q| 4 r| Y s| Y t| PERIODICAL u| 8/8/2001

949 a| TP250.E542 v.121 Jan.-June 1974 w| LCPER c| 1 i| 000048051620 d| 12/16/2011 e| 7/1/2004 l| CATO-PARK m| UP-ANNEX n| 1 q| 2 r| Y s| Y t| PERIODICAL u| 8/8/2001

949 a| TP250.E542 v.120 Oct.-Dec. 1973 w| LCPER c| 1 i| 000048051613 d| 10/17/2006 e| 11/12/2004 l| CATO-PARK m| UP-ANNEX n| 1 q| 1 r| Y s| Y t| PERIODICAL u| 8/8/2001

949 a| TP250.E542 v.120 July-Sept.1973 w| LCPER c| 1 i| 000048050401 l| CATO-PARK m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 8/8/2001

949 a| TP250.E542 v.120 Jan.-June 1973 w| LCPER c| 1 i| 000048050395 d| 6/7/2007 l| CATO-PARK m| UP-ANNEX q| 7 r| Y s| Y t| PERIODICAL u| 8/8/2001

949 a| TP250.E542 v.119 July-Dec.1972 w| LCPER c| 1 i| 000048050388 d| 3/21/2012 e| 4/7/2005 l| CATO-PARK m| UP-ANNEX n| 2 q| 2 r| Y s| Y t| PERIODICAL u| 8/8/2001

949 a| TP250.E542 v.119 Jan.-June 1972 w| LCPER c| 1 i| 000048050371 d| 12/11/2006 e| 11/12/2004 l| CATO-PARK m| UP-ANNEX n| 3 q| 5 r| Y s| Y t| PERIODICAL u| 8/8/2001

949 a| TP250.E542 v.118 July-Dec.1971 w| LCPER c| 1 i| 000048050364 d| 3/14/2006 e| 1/3/2002 l| CATO-PARK m| UP-ANNEX n| 2 q| 4 r| Y s| Y t| PERIODICAL u| 8/8/2001

949 a| TP250.E542 v.118 Jan.-June 1971 w| LCPER c| 1 i| 000048050357 d| 6/5/2007 e| 7/16/2004 l| CATO-PARK m| UP-ANNEX n| 3 q| 2 r| Y s| Y t| PERIODICAL u| 8/8/2001

949 a| TP250.E542 v.117 July-Dec.1970 w| LCPER c| 1 i| 000048050340 d| 8/9/2006 e| 7/8/2004 l| CATO-PARK m| UP-ANNEX n| 1 q| 1 r| Y s| Y t| PERIODICAL u| 8/8/2001

949 a| TP250.E542 v.117 Jan.-June 1970 w| LCPER c| 1 i| 000048050333 d| 6/13/2006 e| 8/27/2003 l| CATO-PARK m| UP-ANNEX n| 1 q| 1 r| Y s| Y t| PERIODICAL u| 8/8/2001

949 a| TP250.E542 v.116 p1475-1760 1C-412C 196 w| LCPER c| 1 i| 000048050326 d| 2/16/2006 e| 6/20/2003 l| CATO-PARK m| UP-ANNEX n| 2 q| 1 r| Y s| Y t| PERIODICAL u| 8/8/2001

949 a| TP250.E542 v.116 p.713-1474 1969 w| LCPER c| 1 i| 000048050319 d| 6/20/2003 e| 6/20/2003 l| CATO-PARK m| UP-ANNEX n| 1 r| Y s| Y t| PERIODICAL u| 8/8/2001

949 a| TP250.E542 v.116 p.1-712 1969 w| LCPER c| 1 i| 000048050302 d| 2/16/2006 l| CATO-PARK m| UP-ANNEX q| 1 r| Y s| Y t| PERIODICAL u| 8/8/2001

949 a| TP250.E542 v.115 p877-1294 1C-364C 1968 w| LCPER c| 1 i| 000048050296 d| 12/16/2014 l| CATO-PARK m| UP-ANNEX q| 5 r| Y s| Y t| PERIODICAL u| 8/8/2001

949 a| TP250.E542 v.115 p.1-876 1968 w| LCPER c| 1 i| 000048050289 d| 11/14/2006 l| CATO-PARK m| UP-ANNEX q| 4 r| Y s| Y t| PERIODICAL u| 8/8/2001

949 a| TP250.E542 v.114 p764-1314 1C-310C 1967 w| LCPER c| 1 i| 000048050272 l| CATO-PARK m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 8/8/2001

949 a| TP250.E542 v.114 p.1-763 1967 w| LCPER c| 1 i| 000048050265 d| 2/9/2007 l| CATO-PARK m| UP-ANNEX q| 1 r| Y s| Y t| PERIODICAL u| 8/8/2001

949 a| TP250.E542 v.113 p864-1354 1C-328C 1966 w| LCPER c| 1 i| 000048050258 d| 9/1/2006 l| CATO-PARK m| UP-ANNEX q| 4 r| Y s| Y t| PERIODICAL u| 8/8/2001

949 a| TP250.E542 v.113 p.1-864 1966 w| LCPER c| 1 i| 000048050241 d| 6/27/2006 l| CATO-PARK m| UP-ANNEX q| 1 r| Y s| Y t| PERIODICAL u| 8/8/2001

949 a| TP250.E542 v.112 p761-1264 7C-288C 1965 w| LCPER c| 1 i| 000048050234 d| 12/13/2005 l| CATO-PARK m| UP-ANNEX q| 2 r| Y s| Y t| PERIODICAL u| 8/8/2001

949 a| TP250.E542 v.112 p.1-760 1965 w| LCPER c| 1 i| 000048050227 d| 1/10/2007 l| CATO-PARK m| UP-ANNEX q| 5 r| Y s| Y t| PERIODICAL u| 8/8/2001

949 a| TP250.E542 v.111 p893-1442 1C-282C 1964 w| LCPER c| 1 i| 000048050210 d| 8/31/2006 l| CATO-PARK m| UP-ANNEX q| 2 r| Y s| Y t| PERIODICAL u| 8/8/2001

949 a| TP250.E542 v.111 p.1-892 1964 w| LCPER c| 1 i| 000048050203 d| 11/14/2006 l| CATO-PARK m| UP-ANNEX q| 4 r| Y s| Y t| PERIODICAL u| 8/8/2001

949 a| TP250.E542 v.110 p709-1294 1C-276C 1963 w| LCPER c| 1 i| 000048050197 d| 6/12/2007 l| CATO-PARK m| UP-ANNEX q| 4 r| Y s| Y t| PERIODICAL u| 8/8/2001

949 a| TP250.E542 v.110 p.1-708 1963 w| LCPER c| 1 i| 000048050180 d| 1/10/2007 l| CATO-PARK m| UP-ANNEX q| 3 r| Y s| Y t| PERIODICAL u| 8/8/2001

949 a| TP250.E542 v.109 p753-1272 1C-310C 1962 w| LCPER c| 1 i| 000048050173 d| 6/12/2007 l| CATO-PARK m| UP-ANNEX q| 5 r| Y s| Y t| PERIODICAL u| 8/8/2001

949 a| TP250.E542 v.109 p.1-752 1962 w| LCPER c| 1 i| 000048050166 l| CATO-PARK m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 8/8/2001

949 a| TP250.E542 v.108 p.717-1174 1C-276 1961 w| LCPER c| 1 i| 000048050142 d| 2/27/2006 e| 2/25/2006 l| CATO-PARK m| UP-ANNEX n| 1 r| Y s| Y t| PERIODICAL u| 8/8/2001

949 a| TP250.E542 v.108 p.1-716 1961 w| LCPER c| 1 i| 000048050135 l| CATO-PARK m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 8/8/2001

949 a| TP250.E542 v.107 p661-1026 1C-278C 1960 w| LCPER c| 1 i| 000048050128 l| CATO-PARK m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 8/8/2001

949 a| TP250.E542 v.107 p.1-660 1C-278C 1960 w| LCPER c| 1 i| 000048050111 d| 11/14/2006 l| CATO-PARK m| UP-ANNEX q| 3 r| Y s| Y t| PERIODICAL u| 8/8/2001

949 a| TP250.E542 v.106 p737-1084 1C-318C 1959 w| LCPER c| 1 i| 000048050104 d| 2/26/2007 l| CATO-PARK m| UP-ANNEX q| 1 r| Y s| Y t| PERIODICAL u| 8/8/2001

949 a| TP250.E542 v.106 p.1-736 1959 w| LCPER c| 1 i| 000048050098 d| 12/13/2006 l| CATO-PARK m| UP-ANNEX q| 3 r| Y s| Y t| PERIODICAL u| 8/8/2001

949 a| TP250.E542 v.105 1958 w| LCPER c| 1 i| 000048050081 d| 4/17/2007 l| CATO-PARK m| UP-ANNEX q| 2 r| Y s| Y t| PERIODICAL u| 8/8/2001

949 a| TP250.E542 v.105 1958 w| LCPER c| 2 i| 000070253993 l| ACAD-BLDG m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 2/3/2011

949 a| TP250.E542 v.104 1957 w| LCPER c| 1 i| 000048051606 d| 9/11/2006 l| CATO-PARK m| UP-ANNEX q| 1 r| Y s| Y t| PERIODICAL u| 8/8/2001

949 a| TP250.E542 v.104 1957 w| LCPER c| 2 i| 000070253986 l| ACAD-BLDG m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 2/3/2011

949 a| TP250.E542 v.103 1956 w| LCPER c| 1 i| 000048051590 d| 11/14/2006 l| CATO-PARK m| UP-ANNEX q| 2 r| Y s| Y t| PERIODICAL u| 8/8/2001

949 a| TP250.E542 v.103 1956 w| LCPER c| 2 i| 000070253979 l| ACAD-BLDG m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 2/3/2011

949 a| TP250.E542 v.102 1955 w| LCPER c| 1 i| 000048051583 d| 2/26/2007 e| 10/13/2004 l| CATO-PARK m| UP-ANNEX n| 1 q| 1 r| Y s| Y t| PERIODICAL u| 8/8/2001

949 a| TP250.E542 v.102 1955 w| LCPER c| 2 i| 000070253962 l| ACAD-BLDG m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 2/3/2011

949 a| TP250.E542 v.101 1954 w| LCPER c| 1 i| 000048051576 l| CATO-PARK m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 8/8/2001

949 a| TP250.E542 v.101 1954 w| LCPER c| 2 i| 000070253955 l| ACAD-BLDG m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 2/3/2011

949 a| TP250.E542 v.100 1953 w| LCPER c| 1 i| 000048051569 d| 8/8/2005 l| CATO-PARK m| UP-ANNEX q| 1 r| Y s| Y t| PERIODICAL u| 8/8/2001

949 a| TP250.E542 v.100 1953 w| LCPER c| 2 i| 000070253948 l| ACAD-BLDG m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 2/3/2011

949 a| TP250.E542 v.99-108 1952-1961 index w| LCPER c| 1 i| 000048050159 l| CATO-PARK m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 8/8/2001

949 a| TP250.E542 v.99-108 1952-1961 index w| LCPER c| 2 i| 000070254044 l| ACAD-BLDG m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 2/3/2011

949 a| TP250.E542 v.99 1952 w| LCPER c| 1 i| 000048051552 d| 2/26/2007 l| CATO-PARK m| UP-ANNEX q| 3 r| Y s| Y t| PERIODICAL u| 8/8/2001

949 a| TP250.E542 v.99 1952 w| LCPER c| 2 i| 000070253931 l| ACAD-BLDG m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 2/3/2011

949 a| TP250.E542 v.98 1951 w| LCPER c| 1 i| 000048051545 d| 1/8/2007 l| CATO-PARK m| UP-ANNEX q| 1 r| Y s| Y t| PERIODICAL u| 8/8/2001

949 a| TP250.E542 v.98 1951 w| LCPER c| 2 i| 000070253924 l| ACAD-BLDG m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 2/3/2011

949 a| TP250.E542 v.97 1950 w| LCPER c| 1 i| 000020142629 d| 7/14/2004 l| ACAD-BLDG m| UP-ANNEX n| 1 r| Y s| Y t| PERIODICAL u| 7/14/2004

949 a| TP250.E542 v.97 1950 w| LCPER c| 2 i| 000020066581 d| 6/7/2007 l| CATO-PARK m| UP-ANNEX q| 3 r| Y s| Y t| PERIODICAL u| 6/8/2006

949 a| TP250.E542 v.150 no.12 2003 w| LCPER c| 1 i| 1376697-323001 l| BINDERY m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 1/29/2004

949 a| TP250.E542 v.115 no.1-6 1968 w| LCPER c| 1 i| 000055878548 d| 3/28/2005 e| 3/25/2005 l| ACAD-BLDG m| UP-ANNEX n| 1 r| Y s| Y t| PERIODICAL u| 3/18/2005

949 a| TP250.E542 v.116 no.1-6 1969 w| LCPER c| 1 i| 000053490698 d| 3/28/2005 e| 3/25/2005 l| ACAD-BLDG m| UP-ANNEX n| 1 r| Y s| Y t| PERIODICAL u| 3/18/2005

949 a| TP250.E542 v.145 no.11-12 1998 w| LCPER c| 1 i| 000048052580 l| BDJNL-PM m| UP-PAMS r| Y s| Y t| PERIODICAL u| 8/8/2001

949 a| TP250.E542 v.153 no.8 2006 w| LCPER c| 1 i| 25650601006 l| CATO-PARK m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 10/5/2006 x| D z| 2565 0| 0601 1| 006

949 a| TP250.E542 v.153 no.7 2006 w| LCPER c| 1 i| 25650601012 l| CATO-PARK m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 10/5/2006 x| D z| 2565 0| 0601 1| 012

949 a| TP250.E542 v.153 no.6 2006 w| LCPER c| 1 i| 25650601002 l| CATO-PARK m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 10/5/2006 x| D z| 2565 0| 0601 1| 002

949 a| TP250.E542 v.153 no.5 2006 w| LCPER c| 1 i| 25690601002 l| CATO-PARK m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 10/5/2006 x| D z| 2569 0| 0601 1| 002

949 a| TP250.E542 v.156 no.5-6 2009 w| LCPER c| 1 i| 25710601001 l| CATO-PARK m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 12/3/2009 x| D z| 2571 0| 0601 1| 001

949 a| TP250.E542 v.157 no.2 2010 w| LCPER c| 1 i| 25660601016 l| CATO-PARK m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 7/14/2010 x| D z| 2566 0| 0601 1| 016

949 a| TP250.E542 v.106 1959 w| LCPER c| 1 i| 000070254006 l| ACAD-BLDG m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 2/3/2011

949 a| TP250.E542 v.107 1960 w| LCPER c| 1 i| 000070254013 l| ACAD-BLDG m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 2/3/2011

949 a| TP250.E542 v.109 1962 w| LCPER c| 1 i| 000070254051 l| ACAD-BLDG m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 2/3/2011

949 a| TP250.E542 v.108 no.1-6 1961 w| LCPER c| 1 i| 000070254020 l| ACAD-BLDG m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 2/3/2011

949 a| TP250.E542 v.108 no.7-12 1961 w| LCPER c| 1 i| 000070254037 l| ACAD-BLDG m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 2/3/2011

949 a| TP250.E542 v.110 1963 w| LCPER c| 1 i| 000070259957 l| ACAD-BLDG m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 2/3/2011

949 a| TP250.E542 v.111 no.7-12 1964 w| LCPER c| 1 i| 000070259964 l| ACAD-BLDG m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 2/3/2011

949 a| TP250.E542 v.111 no.1-6 1964 w| LCPER c| 1 i| 000052242687 l| ACAD-BLDG m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 2/3/2011

949 a| TP250.E542 v.112 no.7-12 1965 w| LCPER c| 1 i| 000070259971 l| ACAD-BLDG m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 2/3/2011

949 a| TP250.E542 v.113 no.1-6 1966 w| LCPER c| 1 i| 000070259988 l| ACAD-BLDG m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 2/3/2011

949 a| TP250.E542 v.114 no.1-6 1967 w| LCPER c| 1 i| 000070260007 l| ACAD-BLDG m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 2/3/2011

949 a| TP250.E542 v.114 no.7-12 1967 w| LCPER c| 1 i| 000070260014 l| ACAD-BLDG m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 2/3/2011

949 a| TP250.E542 v.115 no.7-12 1968 w| LCPER c| 1 i| 000070260021 l| ACAD-BLDG m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 2/3/2011

949 a| TP250.E542 v.116 no.7-12 1969 w| LCPER c| 1 i| 000070260038 l| ACAD-BLDG m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 2/3/2011

949 a| TP250.E542 v.113 no.7-12 1966 w| LCPER c| 1 i| 000070259995 l| ACAD-BLDG m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 2/3/2011

949 a| TP250.E542 v.128 no.1-3 1981 w| LCPER c| 1 i| 000048051842 d| 2/13/2005 e| 2/13/2005 l| CATO-2 m| UP-ANNEX n| 1 r| Y s| Y t| PERIODICAL u| 8/8/2001 z| 7129

949 a| TP250.E542 v.128 no.4-6 1981 w| LCPER c| 1 i| 000048051859 d| 7/14/2005 e| 7/14/2005 l| CATO-2 m| UP-ANNEX n| 1 r| Y s| Y t| PERIODICAL u| 8/8/2001 z| 7129

949 a| TP250.E542 v.128 no.7-9 1981 w| LCPER c| 1 i| 000048051866 d| 6/6/2005 e| 6/6/2005 l| CATO-2 m| UP-ANNEX n| 2 r| Y s| Y t| PERIODICAL u| 8/8/2001 z| 7129

949 a| TP250.E542 v.128 no.10-12 1981 w| LCPER c| 1 i| 000048051873 l| CATO-2 m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 8/8/2001 z| 7129

949 a| TP250.E542 v.129 no.1-3 1982 w| LCPER c| 1 i| 000048051880 l| CATO-2 m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 8/8/2001 z| 7129

949 a| TP250.E542 v.129 no.4-6 1982 w| LCPER c| 1 i| 000048051897 l| CATO-2 m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 8/8/2001 z| 7129

949 a| TP250.E542 v.129 no.7-9 1982 w| LCPER c| 1 i| 000048051903 d| 7/14/2005 e| 7/14/2005 l| CATO-2 m| UP-ANNEX n| 1 r| Y s| Y t| PERIODICAL u| 8/8/2001 z| 7129

949 a| TP250.E542 v.129 no.10-12 1982 w| LCPER c| 1 i| 000048051910 l| CATO-2 m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 8/8/2001 z| 7129

949 a| TP250.E542 v.130 no.1-3 1983 w| LCPER c| 1 i| 000048051927 l| CATO-2 m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 8/8/2001 z| 7129

949 a| TP250.E542 v.130 no.4-6 1983 w| LCPER c| 1 i| 000048051934 l| CATO-2 m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 8/8/2001 z| 7129

949 a| TP250.E542 v.130 no.7-9 1983 w| LCPER c| 1 i| 000048051941 l| CATO-2 m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 8/8/2001 z| 7129

949 a| TP250.E542 v.130 no.10-12 1983 w| LCPER c| 1 i| 000048051958 l| CATO-2 m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 8/8/2001 z| 7129

949 a| TP250.E542 v.131 p.1-690 1984 w| LCPER c| 1 i| 000048051965 d| 12/4/2003 e| 12/4/2003 l| CATO-2 m| UP-ANNEX n| 1 r| Y s| Y t| PERIODICAL u| 8/8/2001 z| 7129

949 a| TP250.E542 v.131 p.691-1464 1984 w| LCPER c| 1 i| 000048051972 l| CATO-2 m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 8/8/2001 z| 7129

949 a| TP250.E542 v.131 p.1465-2210 1984 w| LCPER c| 1 i| 000048051989 l| CATO-2 m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 8/8/2001 z| 7129

949 a| TP250.E542 v.131 p.2211-3034 1984 w| LCPER c| 1 i| 000048051996 l| CATO-2 m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 8/8/2001 z| 7129

949 a| TP250.E542 v.132 p.1-524 1985 w| LCPER c| 1 i| 000048052009 l| CATO-2 m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 8/8/2001 z| 7129

949 a| TP250.E542 v.132 p.525-990 1985 w| LCPER c| 1 i| 000048052016 l| CATO-2 m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 8/8/2001 z| 7129

949 a| TP250.E542 v.132 p.991-1506 1985 w| LCPER c| 1 i| 000048052023 l| CATO-2 m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 8/8/2001 z| 7129

949 a| TP250.E542 v.132 p.1507-2038 1985 w| LCPER c| 1 i| 000048052030 l| CATO-2 m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 8/8/2001 z| 7129

949 a| TP250.E542 v.132 p.2039-2520 1985 w| LCPER c| 1 i| 000048052047 l| CATO-2 m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 8/8/2001 z| 7129

949 a| TP250.E542 v.132 p.2521-3016 1985 w| LCPER c| 1 i| 000048052054 l| CATO-2 m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 8/8/2001 z| 7129

949 a| TP250.E542 v.133 p.1-616 1986 w| LCPER c| 1 i| 000048052061 l| CATO-2 m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 8/8/2001 z| 7129

949 a| TP250.E542 v.133 p.661-1276 1986 w| LCPER c| 1 i| 000048052078 d| 12/4/2003 e| 12/4/2003 l| CATO-2 m| UP-ANNEX n| 1 r| Y s| Y t| PERIODICAL u| 8/8/2001 z| 7129

949 a| TP250.E542 v.133 p.1277-1988 1986 w| LCPER c| 1 i| 000048052085 l| CATO-2 m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 8/8/2001 z| 7129

949 a| TP250.E542 v.133 p.1989-2664 1986 w| LCPER c| 1 i| 000048052092 l| CATO-2 m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 8/8/2001 z| 7129

949 a| TP250.E542 v.134 p.1-770 1987 w| LCPER c| 1 i| 000048052108 l| CATO-2 m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 8/8/2001 z| 7129

949 a| TP250.E542 v.134 p.771-1590 1987 w| LCPER c| 1 i| 000048052115 l| CATO-2 m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 8/8/2001 z| 7129

949 a| TP250.E542 v.134 p.1591-2378 1987 w| LCPER c| 1 i| 000048052122 l| CATO-2 m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 8/8/2001 z| 7129

949 a| TP250.E542 v.134 p.2379-3212 1987 w| LCPER c| 1 i| 000048052139 l| CATO-2 m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 8/8/2001 z| 7129

949 a| TP250.E542 v.135 p.1-790 1988 w| LCPER c| 1 i| 000048052146 l| CATO-2 m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 8/8/2001 z| 7129

949 a| TP250.E542 v.135 p.791-1608 1988 w| LCPER c| 1 i| 000048052153 l| CATO-2 m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 8/8/2001 z| 7129

949 a| TP250.E542 v.135 p.1609-2396 1988 w| LCPER c| 1 i| 000048052160 l| CATO-2 m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 8/8/2001 z| 7129

949 a| TP250.E542 v.135 p.2397-3176 1988 w| LCPER c| 1 i| 000048052177 l| CATO-2 m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 8/8/2001 z| 7129

949 a| TP250.E542 v.136 p.1-592 1989 w| LCPER c| 1 i| 000048052184 d| 6/7/2005 e| 6/7/2005 l| CATO-2 m| UP-ANNEX n| 1 r| Y s| Y t| PERIODICAL u| 8/8/2001 z| 7129

949 a| TP250.E542 v.136 p.593-1248 1989 w| LCPER c| 1 i| 000048052191 l| CATO-2 m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 8/8/2001 z| 7129

949 a| TP250.E542 v.136 p.1249-1850 1989 w| LCPER c| 1 i| 000048052207 l| CATO-2 m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 8/8/2001 z| 7129

949 a| TP250.E542 v.136 p.1851-2436 1989 w| LCPER c| 1 i| 000048052214 l| CATO-2 m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 8/8/2001 z| 7129

949 a| TP250.E542 v.136 p.2437-3146 1989 w| LCPER c| 1 i| 000048052221 d| 11/28/2003 e| 11/28/2003 l| CATO-2 m| UP-ANNEX n| 1 r| Y s| Y t| PERIODICAL u| 8/8/2001 z| 7129

949 a| TP250.E542 v.136 p.3147-3874 1989 w| LCPER c| 1 i| 000048052238 d| 6/20/2003 e| 6/20/2003 l| CATO-2 m| UP-ANNEX n| 1 r| Y s| Y t| PERIODICAL u| 8/8/2001 z| 7129

949 a| TP250.E542 v.137 p.1-742 1990 w| LCPER c| 1 i| 000048052245 d| 2/7/2003 e| 2/7/2003 l| CATO-2 m| UP-ANNEX n| 1 r| Y s| Y t| PERIODICAL u| 8/8/2001 z| 7129

949 a| TP250.E542 v.137 p.743-1326 1990 w| LCPER c| 1 i| 000048052252 d| 6/6/2005 e| 6/6/2005 l| CATO-2 m| UP-ANNEX n| 1 r| Y s| Y t| PERIODICAL u| 8/8/2001 z| 7129

949 a| TP250.E542 v.137 p.1327-2008 1990 w| LCPER c| 1 i| 000048052269 d| 8/6/2018 e| 4/18/2003 l| CATO-2 m| UP-ANNEX n| 1 q| 1 r| Y s| Y t| PERIODICAL u| 8/8/2001 z| 7129

949 a| TP250.E542 v.137 p.2009-2642 1990 w| LCPER c| 1 i| 000048052276 l| CATO-2 m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 8/8/2001 z| 7129

949 a| TP250.E542 v.137 p.2643-3322 1990 w| LCPER c| 1 i| 000048052283 l| CATO-2 m| UP-ANNEX r| Y s| Y t| PERIODICAL u|

	8/8/2001 z| 7129
949	a| TP250.E542 v.137 p.3323-3978 1990 w| LCPER c| 1 i| 000048052290 d| 6/7/2005 e| 6/7/2005 l| CATO-2 m| UP-ANNEX n| 1 r| Y s| Y t| PERIODICAL u| 8/8/2001 z| 7129
949	a| TP250.E542 v.138 p.1-664 1991 w| LCPER c| 1 i| 000048052306 l| CATO-2 m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 8/8/2001 z| 7129
949	a| TP250.E542 v.138 p.665-1208 1991 w| LCPER c| 1 i| 000048052313 l| CATO-2 m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 8/8/2001 z| 7129
949	a| TP250.E542 v.138 p.1209-1866 1991 w| LCPER c| 1 i| 000048052320 l| CATO-2 m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 8/8/2001 z| 7129
949	a| TP250.E542 v.138 p.1867-2484 1991 w| LCPER c| 1 i| 000048052337 d| 5/17/2005 e| 5/17/2005 l| CATO-2 m| UP-ANNEX n| 4 r| Y s| Y t| PERIODICAL u| 8/8/2001 z| 7129
949	a| TP250.E542 v.138 p.2485-3172 1991 w| LCPER c| 1 i| 000048052344 d| 4/23/2002 e| 4/23/2002 l| CATO-2 m| UP-ANNEX n| 1 r| Y s| Y t| PERIODICAL u| 8/8/2001 z| 7129
949	a| TP250.E542 v.138 p.3173-3794 1991 w| LCPER c| 1 i| 000048052351 d| 4/23/2002 e| 4/23/2002 l| CATO-2 m| UP-ANNEX n| 1 r| Y s| Y t| PERIODICAL u| 8/8/2001 z| 7129
949	a| TP250.E542 v.139 no.1-2 P.1-640 1992 w| LCPER c| 1 i| 000048052368 d| 6/16/2005 e| 6/16/2005 l| CATO-2 m| UP-ANNEX n| 1 r| Y s| Y t| PERIODICAL u| 6/16/2005 z| 7129
949	a| TP250.E542 v.139 p.641-1222 1992 w| LCPER c| 1 i| 000048052375 d| 6/7/2005 e| 6/7/2005 l| CATO-2 m| UP-ANNEX n| 2 r| Y s| Y t| PERIODICAL u| 8/8/2001 z| 7129
949	a| TP250.E542 v.139 p.1223-1794 1992 w| LCPER c| 1 i| 000048052382 d| 5/17/2005 e| 5/17/2005 l| CATO-2 m| UP-ANNEX n| 1 r| Y s| Y t| PERIODICAL u| 8/8/2001 z| 7129
949	a| TP250.E542 v.139 p.1795-2358 1992 w| LCPER c| 1 i| 000048052399 l| CATO-2 m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 8/8/2001 z| 7129
949	a| TP250.E542 v.139 p.2359-3018 1992 w| LCPER c| 1 i| 000052514814 d| 5/17/2005 e| 5/17/2005 l| CATO-2 m| UP-ANNEX n| 2 r| Y s| Y t| PERIODICAL u| 8/8/2001 z| 7129
949	a| TP250.E542 v.139 p.3019-3704 1992 w| LCPER c| 1 i| 000054842557 l| CATO-2 m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 8/8/2001 z| 7129
949	a| TP250.E542 v.140 no.1-2 1993 w| LCPER c| 1 i| 000048052702 l| CATO-2 m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 8/8/2001 z| 7129
949	a| TP250.E542 v.140 no.3-4 1993 w| LCPER c| 1 i| 000048052719 d| 5/18/2005 e| 5/18/2005 l| CATO-2 m| UP-ANNEX n| 1 r| Y s| Y t| PERIODICAL u| 8/8/2001 z| 7129
949	a| TP250.E542 v.140 no.5-6 1993 w| LCPER c| 1 i| 000048052726 d| 11/11/2005 e| 11/11/2005 l| CATO-2 m| UP-ANNEX n| 3 r| Y s| Y t| PERIODICAL u| 8/8/2001 z| 7129
949	a| TP250.E542 v.140 no.7-8 1993 w| LCPER c| 1 i| 000048052733 d| 5/18/2005 e| 5/18/2005 l| CATO-2 m| UP-ANNEX n| 4 r| Y s| Y t| PERIODICAL u| 8/8/2001 z| 7129
949	a| TP250.E542 v.140 no.9-10 1993 w| LCPER c| 1 i| 000048052740 l| CATO-2 m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 8/8/2001 z| 7129
949	a| TP250.E542 v.140 no.11-12 1993 w| LCPER c| 1 i| 000048052757 d| 5/18/2005 e| 5/18/2005 l| CATO-2 m| UP-ANNEX n| 3 r| Y s| Y t| PERIODICAL u| 8/8/2001 z| 7129
949	a| TP250.E542 v.141 no.1-3 1994 w| LCPER c| 1 i| 000048052764 l| CATO-2 m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 8/8/2001 z| 7129
949	a| TP250.E542 v.141 no.4-6 1994 w| LCPER c| 1 i| 000048052771 d| 5/18/2005 e| 5/18/2005 l| CATO-2 m| UP-ANNEX n| 1 r| Y s| Y t| PERIODICAL u| 8/8/2001 z| 7129
949	a| TP250.E542 v.141 no.7-8 1994 w| LCPER c| 1 i| 000048052788 l| CATO-2 m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 8/8/2001 z| 7130
949	a| TP250.E542 v.141 no.9-10 1994 w| LCPER c| 1 i| 000048052795 d| 11/25/2003 e| 11/25/2003 l| CATO-2 m| UP-ANNEX n| 1 r| Y s| Y t| PERIODICAL u| 8/8/2001 z| 7130
949	a| TP250.E542 v.141 no.11-12 1994 w| LCPER c| 1 i| 000048052801 d| 5/5/2006 e| 5/5/2006 l| CATO-2 m| UP-ANNEX n| 1 r| Y s| Y t| PERIODICAL u| 8/8/2001 z| 7130
949	a| TP250.E542 v.155 no.7 2008 w| LCPER c| 1 i| 000079866675 l| CATO-2 m| UP-ANNEX r| Y s| Y t| SERIAL u| 1/17/2022 z| 6599
949	a| TP250.E542 v.155 no.8 2008 w| LCPER c| 1 i| 000079866767 l| CATO-2 m| UP-ANNEX r| Y s| Y t| SERIAL u| 1/17/2022 z| 6599
949	a| TP250.E542 v.155 no.9 2008 w| LCPER c| 1 i| 000079866576 l| CATO-2 m| UP-ANNEX r| Y s| Y t| SERIAL u| 1/17/2022 z| 6599
949	a| TP250.E542 v.155 no.10 2008 w| LCPER c| 1 i| 000079866507 l| CATO-2 m| UP-ANNEX r| Y s| Y t| SERIAL u| 1/17/2022 z| 6599
949	a| TP250.E542 v.155 no.12 2008 w| LCPER c| 1 i| 000079866385 l| CATO-2 m| UP-ANNEX r| Y s| Y t| SERIAL u| 1/17/2022 z| 6599
949	a| TP250.E542 v.151 no.1 2004 w| LCPER c| 1 i| 25640601009 l| CATO-PARK m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 9/17/2024 x| D z| 2564 0| 0601 1| 009
949	a| TP250.E542 v.151 no.2 2004 w| LCPER c| 1 i| 25640601008 l| CATO-PARK m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 9/17/2024 x| D z| 2564 0| 0601 1| 008
949	a| TP250.E542 v.151 no.3 2004 w| LCPER c| 1 i| 25640601006 l| CATO-PARK m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 9/17/2024 x| D z| 2564 0| 0601 1| 006
949	a| TP250.E542 v.151 no.4 2004 w| LCPER c| 1 i| 25640601005 l| CATO-PARK m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 9/17/2024 x| D z| 2564 0| 0601 1| 005
949	a| TP250.E542 v.151 no.5 2004 w| LCPER c| 1 i| 25640601011 l| CATO-PARK m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 9/17/2024 x| D z| 2564 0| 0601 1| 011
949	a| TP250.E542 v.151 no.6 2004 w| LCPER c| 1 i| 25640601015 l| CATO-PARK m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 9/17/2024 x| D z| 2564 0| 0601 1| 015
949	a| TP250.E542 v.151 no.7 2004 w| LCPER c| 1 i| 25640601020 l| CATO-PARK m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 9/17/2024 x| D z| 2564 0| 0601 1| 020

949 a| TP250.E542 v.151 no.8 2004 w| LCPER c| 1 i| 25640601019 l| CATO-PARK m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 9/17/2024 x| D z| 2564 0| 0601 1| 019

949 a| TP250.E542 v.151 no.9 2004 w| LCPER c| 1 i| 25640601017 l| CATO-PARK m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 9/17/2024 x| D z| 2564 0| 0601 1| 017

949 a| TP250.E542 v.151 no.10 2004 w| LCPER c| 1 i| 25640601016 l| CATO-PARK m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 9/17/2024 x| D z| 2564 0| 0601 1| 016

949 a| TP250.E542 v.151 no.11 2004 w| LCPER c| 1 i| 25640601030 l| CATO-PARK m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 9/17/2024 x| D z| 2564 0| 0601 1| 030

949 a| TP250.E542 v.151 no.12 2004 w| LCPER c| 1 i| 25640601029 l| CATO-PARK m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 9/17/2024 x| D z| 2564 0| 0601 1| 029

949 a| TP250.E542 v.152 no.1 2005 w| LCPER c| 1 i| 25640601027 l| CATO-PARK m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 9/17/2024 x| D z| 2564 0| 0601 1| 027

949 a| TP250.E542 v.152 no.2 2005 w| LCPER c| 1 i| 25640601026 l| CATO-PARK m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 9/17/2024 x| D z| 2564 0| 0601 1| 026

949 a| TP250.E542 v.152 no.3 2005 w| LCPER c| 1 i| 25640601024 l| CATO-PARK m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 9/17/2024 x| D z| 2564 0| 0601 1| 024

949 a| TP250.E542 v.152 no.4 2005 w| LCPER c| 1 i| 25640601023 l| CATO-PARK m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 9/17/2024 x| D z| 2564 0| 0601 1| 023

949 a| TP250.E542 v.152 no.5 2005 w| LCPER c| 1 i| 25640601022 l| CATO-PARK m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 9/17/2024 x| D z| 2564 0| 0601 1| 022

949 a| TP250.E542 v.152 no.6 2005 w| LCPER c| 1 i| 25650601007 l| CATO-PARK m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 9/17/2024 x| D z| 2565 0| 0601 1| 007

949 a| TP250.E542 v.152 no.7 2005 w| LCPER c| 1 i| 25680601010 l| CATO-PARK m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 9/17/2024 x| D z| 2568 0| 0601 1| 010

949 a| TP250.E542 v.152 no.8 2005 w| LCPER c| 1 i| 25650601010 l| CATO-PARK m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 9/17/2024 x| D z| 2565 0| 0601 1| 010

949 a| TP250.E542 v.152 no.9 2005 w| LCPER c| 1 i| 25650601009 l| CATO-PARK m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 9/17/2024 x| D z| 2565 0| 0601 1| 009

949 a| TP250.E542 v.152 no.10 2005 w| LCPER c| 1 i| 25690601003 l| CATO-PARK m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 9/17/2024 x| D z| 2569 0| 0601 1| 003

949 a| TP250.E542 v.152 no.11 2005 w| LCPER c| 1 i| 25690601004 l| CATO-PARK m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 9/17/2024 x| D z| 2569 0| 0601 1| 004

949 a| TP250.E542 v.152 no.12 2005 w| LCPER c| 1 i| 25680601017 l| CATO-PARK m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 9/17/2024 x| D z| 2568 0| 0601 1| 017

949 a| TP250.E542 v.153 no.1 2006 w| LCPER c| 1 i| 25680601009 l| CATO-PARK m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 9/17/2024 x| D z| 2568 0| 0601 1| 009

949 a| TP250.E542 v.153 no.2 2006 w| LCPER c| 1 i| 25690601001 l| CATO-PARK m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 9/17/2024 x| D z| 2569 0| 0601 1| 001

949 a| TP250.E542 v.153 no.3 2006 w| LCPER c| 1 i| 25650601004 l| CATO-PARK m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 9/17/2024 x| D z| 2565 0| 0601 1| 004

949 a| TP250.E542 v.153 no.4 2006 w| LCPER c| 1 i| 25650601003 l| CATO-PARK m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 9/17/2024 x| D z| 2565 0| 0601 1| 003

949 a| TP250.E542 v.153 no.9 2006 w| LCPER c| 1 i| 25680601020 l| CATO-PARK m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 9/17/2024 x| D z| 2568 0| 0601 1| 020

949 a| TP250.E542 v.153 no.10 2006 w| LCPER c| 1 i| 25680601019 l| CATO-PARK m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 9/17/2024 x| D z| 2568 0| 0601 1| 019

949 a| TP250.E542 v.153 no.11 2006 w| LCPER c| 1 i| 25680601018 l| CATO-PARK m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 9/17/2024 x| D z| 2568 0| 0601 1| 018

949 a| TP250.E542 v.153 no.12 2006 w| LCPER c| 1 i| 25670601040 l| CATO-PARK m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 9/17/2024 x| D z| 2567 0| 0601 1| 040

949 a| TP250.E542 v.154 no.1 2007 w| LCPER c| 1 i| 25670601041 l| CATO-PARK m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 9/17/2024 x| D z| 2567 0| 0601 1| 041

949 a| TP250.E542 v.154 no.2 2007 w| LCPER c| 1 i| 25670601038 l| CATO-PARK m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 9/17/2024 x| D z| 2567 0| 0601 1| 038

949 a| TP250.E542 v.154 no.3 2007 w| LCPER c| 1 i| 25670601039 l| CATO-PARK m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 9/17/2024 x| D z| 2567 0| 0601 1| 039

949 a| TP250.E542 v.154 no.4 2007 w| LCPER c| 1 i| 25700601009 l| CATO-PARK m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 9/17/2024 x| D z| 2570 0| 0601 1| 009

949 a| TP250.E542 v.154 no.5 2007 w| LCPER c| 1 i| 25700601008 l| CATO-PARK m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 9/17/2024 x| D z| 2570 0| 0601 1| 008

949 a| TP250.E542 v.154 no.6 2007 w| LCPER c| 1 i| 25700601007 l| CATO-PARK m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 9/17/2024 x| D z| 2570 0| 0601 1| 007

949 a| TP250.E542 v.155 no.1 2008 w| LCPER c| 1 i| 25650601014 l| CATO-PARK m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 9/17/2024 x| D z| 2565 0| 0601 1| 014

949 a| TP250.E542 v.155 no.2 2008 w| LCPER c| 1 i| 25650601013 l| CATO-PARK m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 9/17/2024 x| D z| 2565 0| 0601 1| 013

949 a| TP250.E542 v.154 no.7 2007 w| LCPER c| 1 i| 25700601006 l| CATO-PARK m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 9/17/2024 x| D z| 2570 0| 0601 1| 006

949 a| TP250.E542 v.154 no.8 2007 w| LCPER c| 1 i| 25700601005 l| CATO-PARK m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 9/17/2024 x|

	D z| 2570 0| 0601 1| 005
949	a| TP250.E542 v.154 no.9 2007 w| LCPER c| 1 i| 25700601017 l| CATO-PARK m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 9/17/2024 x| D z| 2570 0| 0601 1| 017
949	a| TP250.E542 v.154 no.10 2007 w| LCPER c| 1 i| 25700601016 l| CATO-PARK m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 9/17/2024 x| D z| 2570 0| 0601 1| 016
949	a| TP250.E542 v.154 no.11 2007 w| LCPER c| 1 i| 25750601004 l| CATO-PARK m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 9/17/2024 x| D z| 2575 0| 0601 1| 004
949	a| TP250.E542 v.154 no.12 2007 w| LCPER c| 1 i| 25750601005 l| CATO-PARK m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 9/17/2024 x| D z| 2575 0| 0601 1| 005
949	a| TP250.E542 v.155 no.3 2008 w| LCPER c| 1 i| 25700601021 l| CATO-PARK m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 9/17/2024 x| D z| 2570 0| 0601 1| 021
949	a| TP250.E542 v.155 no.4 2008 w| LCPER c| 1 i| 25710601002 l| CATO-PARK m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 9/17/2024 x| D z| 2571 0| 0601 1| 002
949	a| TP250.E542 v.155 no.5 2008 w| LCPER c| 1 i| 25710601003 l| CATO-PARK m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 9/17/2024 x| D z| 2571 0| 0601 1| 003
949	a| TP250.E542 v.155 no.6 2008 w| LCPER c| 1 i| 25710601004 l| CATO-PARK m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 9/17/2024 x| D z| 2571 0| 0601 1| 004
949	a| TP250.E542 v.156 no.1 2009 w| LCPER c| 1 i| 25650601021 l| CATO-PARK m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 9/17/2024 x| D z| 2565 0| 0601 1| 021
949	a| TP250.E542 v.156 no.2 2009 w| LCPER c| 1 i| 25650601018 l| CATO-PARK m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 9/17/2024 x| D z| 2565 0| 0601 1| 018
949	a| TP250.E542 v.156 no.3 2009 w| LCPER c| 1 i| 25650601017 l| CATO-PARK m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 9/17/2024 x| D z| 2565 0| 0601 1| 017
949	a| TP250.E542 v.156 no.4 2009 w| LCPER c| 1 i| 25650601016 l| CATO-PARK m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 9/17/2024 x| D z| 2565 0| 0601 1| 016
949	a| TP250.E542 v.156 no.7 2009 w| LCPER c| 1 i| 25700601015 l| CATO-PARK m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 9/17/2024 x| D z| 2570 0| 0601 1| 015
949	a| TP250.E542 v.156 no.8 2009 w| LCPER c| 1 i| 25700601014 l| CATO-PARK m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 9/17/2024 x| D z| 2570 0| 0601 1| 014
949	a| TP250.E542 v.156 no.9 2009 w| LCPER c| 1 i| 25640601013 l| CATO-PARK m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 9/17/2024 x| D z| 2564 0| 0601 1| 013
949	a| TP250.E542 v.156 no.10 2009 w| LCPER c| 1 i| 25640601012 l| CATO-PARK m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 9/17/2024 x| D z| 2564 0| 0601 1| 012
949	a| TP250.E542 v.156 no.11 2009 w| LCPER c| 1 i| 25640601003 l| CATO-PARK m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 9/17/2024 x| D z| 2564 0| 0601 1| 003
949	a| TP250.E542 v.156 no.12 2009 w| LCPER c| 1 i| 25640601002 l| CATO-PARK m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 9/17/2024 x| D z| 2564 0| 0601 1| 002 2| 0600
949	a| TP250.E542 v.157 no.1 2010 w| LCPER c| 1 i| 25870601002 l| CATO-PARK m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 9/18/2024 x| D z| 2587 0| 0601 1| 002
949	a| TP250.E542 v.157 no.3 2010 w| LCPER c| 1 i| 25870601012 l| CATO-PARK m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 9/18/2024 x| D z| 2587 0| 0601 1| 012
949	a| TP250.E542 v.157 no.4 2010 w| LCPER c| 1 i| 25870601010 l| CATO-PARK m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 9/18/2024 x| D z| 2587 0| 0601 1| 010
949	a| TP250.E542 v.157 no.5 2010 w| LCPER c| 1 i| 26020701030 l| CATO-PARK m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 10/14/2024 x| D z| 2602 0| 0701 1| 030
949	a| TP250.E542 v.157 no.6 2010 w| LCPER c| 1 i| 26020701022 l| CATO-PARK m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 10/14/2024 x| D z| 2602 0| 0701 1| 022
949	a| TP250.E542 v.157 no.7 2010 w| LCPER c| 1 i| 26020701024 l| CATO-PARK m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 10/14/2024 x| D z| 2602 0| 0701 1| 024
949	a| TP250.E542 v.157 no.8 2010 w| LCPER c| 1 i| 26030701050 l| CATO-PARK m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 10/14/2024 x| D z| 2603 0| 0701 1| 050
949	a| TP250.E542 v.157 no.9 2010 w| LCPER c| 1 i| 25860701029 l| CATO-PARK m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 10/14/2024 x| D z| 2586 0| 0701 1| 029
949	a| TP250.E542 v.157 no.10 2010 w| LCPER c| 1 i| 25860701025 l| CATO-PARK m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 10/14/2024 x| D z| 2586 0| 0701 1| 025
949	a| TP250.E542 v.157 no.11 2010 w| LCPER c| 1 i| 25860701026 l| CATO-PARK m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 10/14/2024 x| D z| 2586 0| 0701 1| 026
949	a| TP250.E542 v.157 no.12 2010 w| LCPER c| 1 i| 25860701027 l| CATO-PARK m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 10/14/2024 x| D z| 2586 0| 0701 1| 027
949	a| TP250.E542 v.158 no.1 2011 w| LCPER c| 1 i| 25860701015 l| CATO-PARK m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 10/14/2024 x| D z| 2586 0| 0701 1| 015
949	a| TP250.E542 v.158 no.2 2011 w| LCPER c| 1 i| 26030701049 l| CATO-PARK m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 10/14/2024 x| D z| 2603 0| 0701 1| 049
949	a| TP250.E542 v.158 no.3 2011 w| LCPER c| 1 i| 26030701048 l| CATO-PARK m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 10/14/2024 x| D z| 2603 0| 0701 1| 048
949	a| TP250.E542 v.158 no.4 2011 w| LCPER c| 1 i| 26030701046 l| CATO-PARK m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 10/14/2024 x| D z| 2603 0| 0701 1| 046
949	a| TP250.E542 v.158 no.5 2011 w| LCPER c| 1 i| 26030701045 l| CATO-PARK m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 10/14/2024

			x| D z| 2603 0| 0701 1| 045
949			a| TP250.E542 v.158 no.6 2011 w| LCPER c| 1 i| 26030701044 l| CATO-PARK m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 10/14/2024 x| D z| 2603 0| 0701 1| 044
949			a| TP250.E542 v.158 no.7 2011 w| LCPER c| 1 i| 25860701028 l| CATO-PARK m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 10/14/2024 x| D z| 2586 0| 0701 1| 028
949			a| TP250.E542 v.158 no.8 2011 w| LCPER c| 1 i| 26030701052 l| CATO-PARK m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 10/14/2024 x| D z| 2603 0| 0701 1| 052
949			a| TP250.E542 v.158 no.9 2011 w| LCPER c| 1 i| 26020701031 l| CATO-PARK m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 10/14/2024 x| D z| 2602 0| 0701 1| 031
949			a| TP250.E542 v.158 no.10 2011 w| LCPER c| 1 i| 26020701023 l| CATO-PARK m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 10/14/2024 x| D z| 2602 0| 0701 1| 023
949			a| TP250.E542 v.158 no.11 2011 w| LCPER c| 1 i| 26030701054 l| CATO-PARK m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 10/14/2024 x| D z| 2603 0| 0701 1| 054
949			a| TP250.E542 v.158 no.12 2011 w| LCPER c| 1 i| 26030701053 l| CATO-PARK m| UP-ANNEX r| Y s| Y t| PERIODICAL u| 10/14/2024 x| D z| 2603 0| 0701 1| 053
852	0	1	a| PSt b| UP-ANNEX c| ANNEX h| TP250 i| .E542
866		0 8| 0 a| v.97(1950)-v.141(1994), v.146(1999)-v.155:no.10(2008), v.155:no.12(2008)-v.158(2011)	
852	0	1	a| PSt b| UP-PAMS c| BDJNL-PM h| TP250 i| .E542
866		0 8| 0 a| v.142(1995)-v.145(1998)	
852	8		a| PSt b| HARRISBURG c| PERIOD-HB h| Periodical
866		0 8| 0 a| v.109(1962)-v.137(1990),v.139(1992)-v.149(2002)	

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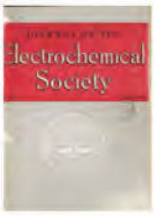
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Journal of the Electrochemical Society

Additional Titles	J. Electrochem. Soc
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Physical Description	volumes : illustrations, portraits ; 23-29 cm
Additional Creators	Electrochemical Society

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Penn State Harrisburg (1 item)

Call number	Material	Location
Harrisburg - Periodicals - 2nd Floor - In-Library Use: Holdings Summary v.109(1962)-v.137(1990),v.139(1992)-v.149(2002)		
Periodical	Bound Journal	Harrisburg - Periodicals - 2nd Floor - In-Library Use

Library Storage (293 items)

Call number	Material	Location
Annexed Material: Holdings Summary v.97(1950)-v.141(1994), v.146(1999)-v.155:no.10(2008), v.155:no.12(2008)-v.158(2011)		
TP250.E542 v.97 1950	Bound Journal	Annexed Material
TP250.E542 v.97 1950	Bound Journal	Annexed Material
TP250.E542 v.98 1951	Bound Journal	Annexed Material
TP250.E542 v.98 1951	Bound Journal	Annexed Material
TP250.E542 v.99 1952	Bound Journal	Annexed Material
TP250.E542 v.99 1952	Bound Journal	Annexed Material
TP250.E542 v.99-108 1952-1961 index	Bound Journal	Annexed Material
TP250.E542 v.99-108 1952-1961 index	Bound Journal	Annexed Material
TP250.E542 v.100 1953	Bound Journal	Annexed Material
TP250.E542 v.100 1953	Bound Journal	Annexed Material
TP250.E542 v.101 1954	Bound Journal	Annexed Material
TP250.E542 v.101 1954	Bound Journal	Annexed Material
TP250.E542 v.102 1955	Bound Journal	Annexed Material
TP250.E542 v.102 1955	Bound Journal	Annexed Material
TP250.E542 v.103 1956	Bound Journal	Annexed Material
TP250.E542 v.103 1956	Bound Journal	Annexed Material
TP250.E542 v.104 1957	Bound Journal	Annexed Material
TP250.E542 v.104 1957	Bound Journal	Annexed Material
TP250.E542 v.105 1958	Bound Journal	Annexed Material
TP250.E542 v.105 1958	Bound Journal	Annexed Material
TP250.E542 v.106 1959	Bound Journal	Annexed Material
TP250.E542 v.106 p.1-736 1959	Bound Journal	Annexed Material
TP250.E542 v.106 p737-1084 1C-318C 1959	Bound Journal	Annexed Material

TP250.E542 v.107 1960	Bound Journal	Annexed Material
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TP250.E542 v.108 no.1-6 1961	Bound Journal	Annexed Material
TP250.E542 v.108 no.7-12 1961	Bound Journal	Annexed Material
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TP250.E542 v.108 p.717-1174 1C-276 1961	Bound Journal	Annexed Material
TP250.E542 v.109 1962	Bound Journal	Annexed Material
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TP250.E542 v.110 1963	Bound Journal	Annexed Material
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TP250.E542 v.113 no.7-12 1966	Bound Journal	Annexed Material
TP250.E542 v.113 p.1-864 1966	Bound Journal	Annexed Material
TP250.E542 v.113 p864-1354 1C-328C 1966	Bound Journal	Annexed Material
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TP250.E542 v.114 no.7-12 1967	Bound Journal	Annexed Material
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TP250.E542 v.115 no.1-6 1968	Bound Journal	Annexed Material
TP250.E542 v.115 no.7-12 1968	Bound Journal	Annexed Material
TP250.E542 v.115 p.1-876 1968	Bound Journal	Annexed Material
TP250.E542 v.115 p877-1294 1C-364C 1968	Bound Journal	Annexed Material
TP250.E542 v.116 no.1-6 1969	Bound Journal	Annexed Material
TP250.E542 v.116 no.7-12 1969	Bound Journal	Annexed Material
TP250.E542 v.116 p.1-712 1969	Bound Journal	Annexed Material
TP250.E542 v.116 p.713-1474 1969	Bound Journal	Annexed Material
TP250.E542 v.116 p1475-1760 1C-412C 196	Bound Journal	Annexed Material
TP250.E542 v.117 Jan.-June 1970	Bound Journal	Annexed Material
TP250.E542 v.117 July-Dec.1970	Bound Journal	Annexed Material
TP250.E542 v.118 Jan.-June 1971	Bound Journal	Annexed Material
TP250.E542 v.118 July-Dec.1971	Bound Journal	Annexed Material
TP250.E542 v.119 Jan.-June 1972	Bound Journal	Annexed Material
TP250.E542 v.119 July-Dec.1972	Bound Journal	Annexed Material
TP250.E542 v.120 Jan.-June 1973	Bound Journal	Annexed Material
TP250.E542 v.120 July-Sept.1973	Bound Journal	Annexed Material
TP250.E542 v.120 Oct.-Dec. 1973	Bound Journal	Annexed Material
TP250.E542 v.121 Jan.-June 1974	Bound Journal	Annexed Material
TP250.E542 v.121 July-Dec.1974	Bound Journal	Annexed Material

TP250.E542 v.122 Jan.-June 1975	Bound Journal	Annexed Material
TP250.E542 v.122 July-Dec.1975	Bound Journal	Annexed Material
TP250.E542 v.123 no.1-4 1976	Bound Journal	Annexed Material
TP250.E542 v.123 no.1-6 1976	Bound Journal	Annexed Material
TP250.E542 v.123 no.5-8 1976	Bound Journal	Annexed Material
TP250.E542 v.123 no.9-12 1976	Bound Journal	Annexed Material
TP250.E542 v.124 no.1-4 1977	Bound Journal	Annexed Material
TP250.E542 v.124 no.5-8 1977	Bound Journal	Annexed Material
TP250.E542 v.124 no.9-12 1977	Bound Journal	Annexed Material
TP250.E542 v.125 no.1-3 1978	Bound Journal	Annexed Material
TP250.E542 v.125 no.4-7 1978	Bound Journal	Annexed Material
TP250.E542 v.125 no.7-12 1978	Bound Journal	Annexed Material
TP250.E542 v.125 no.8-10 1978	Bound Journal	Annexed Material
TP250.E542 v.126 no.1-3 1979	Bound Journal	Annexed Material
TP250.E542 v.126 no.4-6 1979	Bound Journal	Annexed Material
TP250.E542 v.126 no.7-9 1979	Bound Journal	Annexed Material
TP250.E542 v.126 no.10-12 1979	Bound Journal	Annexed Material
TP250.E542 v.127 no.1-3 1980	Bound Journal	Annexed Material
TP250.E542 v.127 no.4-6 1980	Bound Journal	Annexed Material
TP250.E542 v.127 no.7-8 1980	Bound Journal	Annexed Material
TP250.E542 v.127 no.9-12 1980	Bound Journal	Annexed Material
TP250.E542 v.127 no.10-12 1980	Bound Journal	Annexed Material
TP250.E542 v.128 no.1-3 1981	Bound Journal	Annexed Material
TP250.E542 v.128 no.4-6 1981	Bound Journal	Annexed Material
TP250.E542 v.128 no.7-9 1981	Bound Journal	Annexed Material
TP250.E542 v.128 no.10-12 1981	Bound Journal	Annexed Material
TP250.E542 v.129 no.1-3 1982	Bound Journal	Annexed Material
TP250.E542 v.129 no.4-6 1982	Bound Journal	Annexed Material
TP250.E542 v.129 no.7-9 1982	Bound Journal	Annexed Material
TP250.E542 v.129 no.10-12 1982	Bound Journal	Annexed Material
TP250.E542 v.130 no.1-3 1983	Bound Journal	Annexed Material
TP250.E542 v.130 no.4-6 1983	Bound Journal	Annexed Material
TP250.E542 v.130 no.7-9 1983	Bound Journal	Annexed Material
TP250.E542 v.130 no.10-12 1983	Bound Journal	Annexed Material
TP250.E542 v.131 p.1-690 1984	Bound Journal	Annexed Material
TP250.E542 v.131 p.691-1464 1984	Bound Journal	Annexed Material
TP250.E542 v.131 p.1465-2210 1984	Bound Journal	Annexed Material
TP250.E542 v.131 p.2211-3034 1984	Bound Journal	Annexed Material
TP250.E542 v.132 p.1-524 1985	Bound Journal	Annexed Material
TP250.E542 v.132 p.525-990 1985	Bound Journal	Annexed Material
TP250.E542 v.132 p.991-1506 1985	Bound Journal	Annexed Material
TP250.E542 v.132 p.1507-2038 1985	Bound Journal	Annexed Material
TP250.E542 v.132 p.2039-2520 1985	Bound Journal	Annexed Material
TP250.E542 v.132 p.2521-3016 1985	Bound Journal	Annexed Material
TP250.E542 v.133 p.1-616 1986	Bound Journal	Annexed Material
TP250.E542 v.133 p.661-1276 1986	Bound Journal	Annexed Material
TP250.E542 v.133 p.1277-1988 1986	Bound Journal	Annexed Material
TP250.E542 v.133 p.1989-2664 1986	Bound Journal	Annexed Material

TP250.E542 v.134 p.1-770 1987	Bound Journal	Annexed Material
TP250.E542 v.134 p.771-1590 1987	Bound Journal	Annexed Material
TP250.E542 v.134 p.1591-2378 1987	Bound Journal	Annexed Material
TP250.E542 v.134 p.2379-3212 1987	Bound Journal	Annexed Material
TP250.E542 v.135 p.1-790 1988	Bound Journal	Annexed Material
TP250.E542 v.135 p.791-1608 1988	Bound Journal	Annexed Material
TP250.E542 v.135 p.1609-2396 1988	Bound Journal	Annexed Material
TP250.E542 v.135 p.2397-3176 1988	Bound Journal	Annexed Material
TP250.E542 v.136 p.1-592 1989	Bound Journal	Annexed Material
TP250.E542 v.136 p.593-1248 1989	Bound Journal	Annexed Material
TP250.E542 v.136 p.1249-1850 1989	Bound Journal	Annexed Material
TP250.E542 v.136 p.1851-2436 1989	Bound Journal	Annexed Material
TP250.E542 v.136 p.2437-3146 1989	Bound Journal	Annexed Material
TP250.E542 v.136 p.3147-3874 1989	Bound Journal	Annexed Material
TP250.E542 v.137 p.1-742 1990	Bound Journal	Annexed Material
TP250.E542 v.137 p.743-1326 1990	Bound Journal	Annexed Material
TP250.E542 v.137 p.1327-2008 1990	Bound Journal	Annexed Material
TP250.E542 v.137 p.2009-2642 1990	Bound Journal	Annexed Material
TP250.E542 v.137 p.2643-3322 1990	Bound Journal	Annexed Material
TP250.E542 v.137 p.3323-3978 1990	Bound Journal	Annexed Material
TP250.E542 v.138 p.1-664 1991	Bound Journal	Annexed Material
TP250.E542 v.138 p.665-1208 1991	Bound Journal	Annexed Material
TP250.E542 v.138 p.1209-1866 1991	Bound Journal	Annexed Material
TP250.E542 v.138 p.1867-2484 1991	Bound Journal	Annexed Material
TP250.E542 v.138 p.2485-3172 1991	Bound Journal	Annexed Material
TP250.E542 v.138 p.3173-3794 1991	Bound Journal	Annexed Material
TP250.E542 v.139 no.1-2 P.1-640 1992	Bound Journal	Annexed Material
TP250.E542 v.139 p.641-1222 1992	Bound Journal	Annexed Material
TP250.E542 v.139 p.1223-1794 1992	Bound Journal	Annexed Material
TP250.E542 v.139 p.1795-2358 1992	Bound Journal	Annexed Material
TP250.E542 v.139 p.2359-3018 1992	Bound Journal	Annexed Material
TP250.E542 v.139 p.3019-3704 1992	Bound Journal	Annexed Material
TP250.E542 v.140 no.1-2 1993	Bound Journal	Annexed Material
TP250.E542 v.140 no.3-4 1993	Bound Journal	Annexed Material
TP250.E542 v.140 no.5-6 1993	Bound Journal	Annexed Material
TP250.E542 v.140 no.7-8 1993	Bound Journal	Annexed Material
TP250.E542 v.140 no.9-10 1993	Bound Journal	Annexed Material
TP250.E542 v.140 no.11-12 1993	Bound Journal	Annexed Material
TP250.E542 v.141 no.1-3 1994	Bound Journal	Annexed Material
TP250.E542 v.141 no.4-6 1994	Bound Journal	Annexed Material
TP250.E542 v.141 no.7-8 1994	Bound Journal	Annexed Material
TP250.E542 v.141 no.9-10 1994	Bound Journal	Annexed Material
TP250.E542 v.141 no.11-12 1994	Bound Journal	Annexed Material
TP250.E542 v.146 no.1-2 1999	Bound Journal	Annexed Material
TP250.E542 v.146 no.3-4 1999	Bound Journal	Annexed Material
TP250.E542 v.146 no.5-6 1999	Bound Journal	Annexed Material
TP250.E542 v.146 no.7-8 1999	Bound Journal	Annexed Material
TP250.E542 v.146 no.9-10 1999	Bound Journal	Annexed Material
TP250.E542 v.146 no.11-12 1999	Bound Journal	Annexed Material

TP250.E542 v.147 no.1-2 2000	Bound Journal	Annexed Material
TP250.E542 v.147 no.3-4 2000	Bound Journal	Annexed Material
TP250.E542 v.147 no.5-6 2000	Bound Journal	Annexed Material
TP250.E542 v.147 no.7-8 2000	Bound Journal	Annexed Material
TP250.E542 v.147 no.9-10 2000	Bound Journal	Annexed Material
TP250.E542 v.147 no.11-12 2000	Bound Journal	Annexed Material
TP250.E542 v.148 no.1-2 2001	Bound Journal	Annexed Material
TP250.E542 v.148 no.3-4 2001	Bound Journal	Annexed Material
TP250.E542 v.148 no.5-6 2001	Bound Journal	Annexed Material
TP250.E542 v.148 no.7-8 2001	Bound Journal	Annexed Material
TP250.E542 v.148 no.9-10 2001	Bound Journal	Annexed Material
TP250.E542 v.148 no.11-12 2001	Bound Journal	Annexed Material
TP250.E542 v.149 no.1-2 2002	Bound Journal	Annexed Material
TP250.E542 v.149 no.3-4 2002	Bound Journal	Annexed Material
TP250.E542 v.149 no.5-6 2002	Bound Journal	Annexed Material
TP250.E542 v.149 no.7-8 2002	Bound Journal	Annexed Material
TP250.E542 v.149 no.9-10 2002	Bound Journal	Annexed Material
TP250.E542 v.149 no.11-12 2002	Bound Journal	Annexed Material
TP250.E542 v.150 no.1 2003	Bound Journal	Annexed Material
TP250.E542 v.150 no.2 2003	Bound Journal	Annexed Material
TP250.E542 v.150 no.3 2003	Bound Journal	Annexed Material
TP250.E542 v.150 no.4 2003	Bound Journal	Annexed Material
TP250.E542 v.150 no.5 2003	Bound Journal	Annexed Material
TP250.E542 v.150 no.6 2003	Bound Journal	Annexed Material
TP250.E542 v.150 no.7 2003	Bound Journal	Annexed Material
TP250.E542 v.150 no.8 2003	Bound Journal	Annexed Material
TP250.E542 v.150 no.9 2003	Bound Journal	Annexed Material
TP250.E542 v.150 no.10 2003	Bound Journal	Annexed Material
TP250.E542 v.150 no.11 2003	Bound Journal	Annexed Material
TP250.E542 v.150 no.12 2003	Bound Journal	At bindery
TP250.E542 v.151 no.1 2004	Bound Journal	On hold at Penn State Greater Allegheny
TP250.E542 v.151 no.2 2004	Bound Journal	Annexed Material
TP250.E542 v.151 no.3 2004	Bound Journal	Annexed Material
TP250.E542 v.151 no.4 2004	Bound Journal	Annexed Material
TP250.E542 v.151 no.5 2004	Bound Journal	Annexed Material
TP250.E542 v.151 no.6 2004	Bound Journal	Annexed Material
TP250.E542 v.151 no.7 2004	Bound Journal	Annexed Material
TP250.E542 v.151 no.8 2004	Bound Journal	Annexed Material
TP250.E542 v.151 no.9 2004	Bound Journal	Annexed Material
TP250.E542 v.151 no.10 2004	Bound Journal	Annexed Material
TP250.E542 v.151 no.11 2004	Bound Journal	Annexed Material
TP250.E542 v.151 no.12 2004	Bound Journal	Annexed Material
TP250.E542 v.152 no.1 2005	Bound Journal	Annexed Material
TP250.E542 v.152 no.2 2005	Bound Journal	Annexed Material
TP250.E542 v.152 no.3 2005	Bound Journal	Annexed Material
TP250.E542 v.152 no.4 2005	Bound Journal	Annexed Material
TP250.E542 v.152 no.5 2005	Bound Journal	Annexed Material
TP250.E542 v.152 no.6 2005	Bound Journal	Annexed Material

TP250.E542 v.152 no.7 2005	Bound Journal	Annexed Material
TP250.E542 v.152 no.8 2005	Bound Journal	Annexed Material
TP250.E542 v.152 no.9 2005	Bound Journal	Annexed Material
TP250.E542 v.152 no.10 2005	Bound Journal	Annexed Material
TP250.E542 v.152 no.11 2005	Bound Journal	Annexed Material
TP250.E542 v.152 no.12 2005	Bound Journal	Annexed Material
TP250.E542 v.153 no.1 2006	Bound Journal	Annexed Material
TP250.E542 v.153 no.2 2006	Bound Journal	Annexed Material
TP250.E542 v.153 no.3 2006	Bound Journal	Annexed Material
TP250.E542 v.153 no.4 2006	Bound Journal	Annexed Material
TP250.E542 v.153 no.5 2006	Bound Journal	Annexed Material
TP250.E542 v.153 no.6 2006	Bound Journal	Annexed Material
TP250.E542 v.153 no.7 2006	Bound Journal	Annexed Material
TP250.E542 v.153 no.8 2006	Bound Journal	Annexed Material
TP250.E542 v.153 no.9 2006	Bound Journal	Annexed Material
TP250.E542 v.153 no.10 2006	Bound Journal	Annexed Material
TP250.E542 v.153 no.11 2006	Bound Journal	Annexed Material
TP250.E542 v.153 no.12 2006	Bound Journal	Annexed Material
TP250.E542 v.154 no.1 2007	Bound Journal	Annexed Material
TP250.E542 v.154 no.2 2007	Bound Journal	Annexed Material
TP250.E542 v.154 no.3 2007	Bound Journal	Annexed Material
TP250.E542 v.154 no.4 2007	Bound Journal	Annexed Material
TP250.E542 v.154 no.5 2007	Bound Journal	Annexed Material
TP250.E542 v.154 no.6 2007	Bound Journal	Annexed Material
TP250.E542 v.154 no.7 2007	Bound Journal	Annexed Material
TP250.E542 v.154 no.8 2007	Bound Journal	Annexed Material
TP250.E542 v.154 no.9 2007	Bound Journal	Annexed Material
TP250.E542 v.154 no.10 2007	Bound Journal	Annexed Material
TP250.E542 v.154 no.11 2007	Bound Journal	Annexed Material
TP250.E542 v.154 no.12 2007	Bound Journal	Annexed Material
TP250.E542 v.155 no.1 2008	Bound Journal	Annexed Material
TP250.E542 v.155 no.2 2008	Bound Journal	Annexed Material
TP250.E542 v.155 no.3 2008	Bound Journal	Annexed Material
TP250.E542 v.155 no.4 2008	Bound Journal	Annexed Material
TP250.E542 v.155 no.5 2008	Bound Journal	Annexed Material
TP250.E542 v.155 no.6 2008	Bound Journal	Annexed Material
TP250.E542 v.155 no.7 2008	Book	Annexed Material
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TP250.E542 v.156 no.1 2009	Bound Journal	Annexed Material
TP250.E542 v.156 no.2 2009	Bound Journal	Annexed Material
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TP250.E542 v.156 no.4 2009	Bound Journal	Annexed Material
TP250.E542 v.156 no.5-6 2009	Bound Journal	Annexed Material
TP250.E542 v.156 no.7 2009	Bound Journal	Annexed Material
TP250.E542 v.156 no.8 2009	Bound Journal	Annexed Material
TP250.E542 v.156 no.9 2009	Bound Journal	Annexed Material

TP250.E542 v.156 no.10 2009	Bound Journal	Annexed Material
TP250.E542 v.156 no.11 2009	Bound Journal	Annexed Material
TP250.E542 v.156 no.12 2009	Bound Journal	Annexed Material
TP250.E542 v.157 no.1 2010	Bound Journal	Annexed Material
TP250.E542 v.157 no.2 2010	Bound Journal	Annexed Material
TP250.E542 v.157 no.3 2010	Bound Journal	Annexed Material
TP250.E542 v.157 no.4 2010	Bound Journal	Annexed Material
TP250.E542 v.157 no.5 2010	Bound Journal	Annexed Material
TP250.E542 v.157 no.6 2010	Bound Journal	Annexed Material
TP250.E542 v.157 no.7 2010	Bound Journal	Annexed Material
TP250.E542 v.157 no.8 2010	Bound Journal	Annexed Material
TP250.E542 v.157 no.9 2010	Bound Journal	Annexed Material
TP250.E542 v.157 no.10 2010	Bound Journal	Annexed Material
TP250.E542 v.157 no.11 2010	Bound Journal	Annexed Material
TP250.E542 v.157 no.12 2010	Bound Journal	Annexed Material
TP250.E542 v.158 no.1 2011	Bound Journal	Annexed Material
TP250.E542 v.158 no.2 2011	Bound Journal	Annexed Material
TP250.E542 v.158 no.3 2011	Bound Journal	Annexed Material
TP250.E542 v.158 no.4 2011	Bound Journal	Annexed Material
TP250.E542 v.158 no.5 2011	Bound Journal	Annexed Material
TP250.E542 v.158 no.6 2011	Bound Journal	Annexed Material
TP250.E542 v.158 no.7 2011	Bound Journal	Annexed Material
TP250.E542 v.158 no.8 2011	Bound Journal	Annexed Material
TP250.E542 v.158 no.9 2011	Bound Journal	Annexed Material
TP250.E542 v.158 no.10 2011	Bound Journal	Annexed Material
TP250.E542 v.158 no.11 2011	Bound Journal	Annexed Material
TP250.E542 v.158 no.12 2011	Bound Journal	Annexed Material

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TP250.E542 v.142 no.9-10 1995	Bound Journal	Physical & Mathematical Sciences Library, 201 Davey Lab - Bound Journal Collection
TP250.E542 v.142 no.11-12 1995	Bound Journal	Physical & Mathematical Sciences Library, 201 Davey Lab - Bound Journal Collection
TP250.E542 v.143 no.1-2 1996	Bound Journal	Physical & Mathematical Sciences Library, 201 Davey Lab - Bound Journal Collection
TP250.E542 v.143 no.3-4 1996	Bound Journal	Physical & Mathematical Sciences Library, 201 Davey Lab - Bound Journal Collection
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TP250.E542 v.143 no.7-8 1996	Bound Journal	Physical & Mathematical Sciences Library, 201 Davey Lab - Bound Journal Collection
TP250.E542 v.143 no.9-10 1996	Bound Journal	Physical & Mathematical Sciences Library, 201 Davey Lab - Bound Journal Collection
TP250.E542 v.143 no.11-12 1996	Bound Journal	Physical & Mathematical Sciences Library, 201 Davey Lab - Bound Journal Collection
TP250.E542 v.144 no.1-2 1997	Bound Journal	Physical & Mathematical Sciences Library, 201 Davey Lab - Bound Journal Collection
TP250.E542 v.144 no.3-4 1997	Bound Journal	Physical & Mathematical Sciences Library, 201 Davey Lab - Bound Journal Collection
TP250.E542 v.144 no.5-6 1997	Bound Journal	Physical & Mathematical Sciences Library, 201 Davey Lab - Bound Journal Collection
TP250.E542 v.144 no.7-8 1997	Bound Journal	Physical & Mathematical Sciences Library, 201 Davey Lab - Bound Journal Collection
TP250.E542 v.144 no.9-10 1997	Bound Journal	Physical & Mathematical Sciences Library, 201 Davey Lab - Bound Journal Collection

TP250.E542 v.144 no.11-12 1997	Bound Journal	Physical & Mathematical Sciences Library, 201 Davey Lab - Bound Journal Collection
TP250.E542 v.145 no.1-2 1998	Bound Journal	Physical & Mathematical Sciences Library, 201 Davey Lab - Bound Journal Collection
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Table of Contents

Batteries, Fuel Cells, and Energy Conversion

Influences of Treatment Temperature and Water Content on Capacity and Rechargeability of V_2O_5 Xerogel Films
J. Wang, C. J. Curtis, D. L. Schulz, J.-G. Zhang A1

Conductivity of PBI Membranes for High-Temperature Polymer Electrolyte Fuel Cells
Y.-L. Ma, J. S. Wainright, M. H. Litt, R. F. Savinell A8

Studies of Capacity Losses in Cycles and Storages for a $Li_{1.1}Mn_{1.9}O_4$ Positive Electrode
M. Saitoh, M. Sano, M. Fujita, M. Sakata, M. Takata, E. Nishibori A17

Vinylene Carbonate and Li Salicylatoborate as Additives in $LiPF_3(CF_2CF_3)_3$ Solutions for Rechargeable Li-Ion Batteries
D. Aurbach, J. S. Gnanaraj, W. Geissler, M. Schmidt A23

Toward Efficient Electrochemical Synthesis of Fe(VI) Ferrate and Super-Iron Battery Compounds
S. Licht, R. Tel-Vered, L. Halperin A31

Conductivity and Viscosity of PC-DEC and PC-EC Solutions of $LiBF_4$
M. S. Ding A40

Catalyst Microstructure Examination of PEMFC Membrane Electrode Assemblies *vs.* Time
X. Cheng, L. Chen, C. Peng, Z. Chen, Y. Zhang, Q. Fan A48

New $LiNi_yCo_{1-2y}Mn_{1+y}O_4$ Spinel Oxide Solid Solutions as 5 V Electrode Material for Li-Ion Batteries
R. Alcántara, M. Jaraba, P. Lavela, J. L. Tirado A53

Electrochemical Reduction of Oxygen in Some Hydrophobic Room-Temperature Molten Salt Systems
Y. Katayama, H. Onodera, M. Yamagata, T. Miura A59

Influence of Nafion Content in Electrodes on Performance of Carbon Supercapacitors
F. Lufrano, P. Staiti, M. Minutoli A64

Comparative Studies of Methanol Crossover and Cell Performance for a DMFC
R. Jiang, D. Chu A69

Wetting Characteristics of Carbonate Melts under MCFC Operating Conditions
S.-G. Hong, J. Robert Selman A77

Study of Charge Kinetics in Valve-Regulated Lead-Acid Cells
D. M. Bernardi, R. Y. Ying, P. Watson A85

Study of PEFCs by AC Impedance, Current Interrupt, and Dew Point Measurements
I. Effect of Humidity in Oxygen Gas
T. Abe, H. Shima, K. Watanabe, Y. Ito A101

Preparation of $Li_{4/3}Ti_{5/3}O_4$ Thin Film Electrodes by a PVP Sol-Gel Coating Method and Their Electrochemical Properties
Y. H. Rho, K. Kanamura A106

Investigation of Lithium Electrodeposits Formed in Practical Rechargeable Li-Li_xMnO_2 Batteries Based on $LiAsF_6$/1,3-Dioxolane Solutions
E. Zinigrad, E. Levi, H. Teller, G. Salitra, D. Aurbach, P. Dan A111

Ion Transport Properties of Six Lithium Salts Dissolved in γ-Butyrolactone Studied by Self-Diffusion and Ionic Conductivity Measurements
Y. Aihara, T. Bando, H. Nakagawa, H. Yoshida, K. Hayamizu, E. Akiba, W. S. Price A119

Study of the Mechanism of the Vanadium 4+/5+ Redox Reaction in Acidic Solutions
M. Gattrell, J. Park, B. MacDougall, J. Apte, S. McCarthy, C. W. Wu A123

Journal of The Electrochemical Society
2004 • Vol. 151, No. 1

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Kinetic Study of Electro-oxidation of Formic Acid on Spontaneously-Deposited Pt/Pd Nanoparticles
CO Tolerant Fuel Cell Chemistry
M. Zhao, C. Rice, R. I. Masel, P. Waszczuk, A. Wieckowski A131

Self-Discharge and Charge Retention in AB_2-Based Nickel Metal Hydride Batteries
X.-G. Yang, B. Y. Liaw A137

Direct Dimethyl Ether Polymer Electrolyte Fuel Cells for Portable Applications
M. M. Mench, H. M. Chance, C. Y. Wang A144

Synthesis, Characterization, and Electrochemical Properties of Nanocrystalline Silver Thin Films Obtained by Spray Pyrolysis
J. Morales, L. Sánchez, F. Martín, J. R. Ramos-Barrado, M. Sánchez A151

Reverse Micelle Assisted Dispersion of Lanthanum Manganite on Carbon Support for Oxygen Reduction Cathode
M. Hayashi, H. Uemura, K. Shimanoe, N. Miura, N. Yamazoe A158

Cathode Micromodel of Solid Oxide Fuel Cell
S. H. Chan, X. J. Chen, K. A. Khor A164

Electrochemical and Structural Properties of a 4.7 V-Class $LiNi_{0.5}Mn_{1.5}O_4$ Positive Electrode Material Prepared with a Self-Reaction Method
K. Takahashi, M. Saitoh, M. Sano, M. Fujita, K. Kifune A173

Reduction Mechanisms of Ethylene, Propylene, and Vinylethylene Carbonates
A Quantum Chemical Study
J. M. Vollmer, L. A. Curtiss, D. R. Vissers, K. Amine A178

Corrosion, Passivation, and Anodic Films

Characterization of Oxide Films Formed on Mg-Based WE43 Alloy Using AC/DC Anodization in Silicate Solutions
V. Birss, S. Xia, R. Yue, R. G. Rateick, Jr. B1

Inhibition Effect of AC-Treated, Mixed Self-Assembled Film of Phenylthiourea and 1-Dodecanethiol on Copper Corrosion
C. Wang, S. Chen, S. Zhao B11

Effect of Copper Enrichment on the Electrochemical Potential of Binary Al-Cu Alloys
S. Garcia-Vergara, F. Colin, P. Skeldon, G. E. Thompson, P. Bailey, T. C. Q. Noakes, H. Habazaki, K. Shimizu B16

Positron Annihilation Spectroscopy Study of Interfacial Defects Formed by Anodic Oxidation of Aluminum
K. R. Hebert, T. Gessmann, K. G. Lynn, P. Asoka-Kumar B22

Purity Effect on Oxidation Kinetics of Copper at 800-1050°C
Y. Zhu, K. Mimura, M. Isshiki B27

Electrochemical/Chemical Deposition and Etching

Electroless Deposition of Soft Magnetic CoNiP Thin Films
S. K. Murthy, J. K. Vemagiri, R. A. Gunasekaran, P. Coane, K. Varabramyan C1

Nonanomalous Electrodeposition of Zinc-Iron Alloys in an Acidic Zinc Chloride-1-ethyl-3-methylimidazolium Chloride Ionic Liquid
J.-F. Huang, I-Wen Sun C8

Effect of S on Passivation of Ni Plating
S. Arai, T. Hasegawa, N. Kaneko C15

An Exact Algebraic Solution for the Incubation Period of Superfill
D. Josell, T. P. Moffat, D. Wheeler C19

Effects of Organic Additives on Initial Stages of Zinc Electroplating on Iron
J.-Y. Lee, J.-W. Kim, M.-K. Lee, H.-J. Shin, H.-T. Kim, S.-M. Park C25

Porous Silicon Formation under Constant Anodization Conditions: Homogeneous Regime or Transition?
D. Hamm, T. Sakka, Y. H. Ogata C32

Fabrication of TiO_2-$Ru(O_2)$/Al_2O_3 Composite Nanostructures on Glass by Al Anodization and Electrodeposition
S. Z. Chu, S. Inoue, K. Wada, S. Hishita C38

Interpretation of Quantitative Crystallographic Texture in Copper Electrodeposits on Amorphous Substrates
K. Pantleon, J. A. D. Jensen, M. A. J. Somers C45

Photo-Induced Atomic Layer Deposition of Tantalum Oxide Thin Films from $Ta(OC_2H_5)_5$ and O_2
Y.-H. Lee, J.-C. Kwak, B.-S. Gang, H.-C. Kim, B.-H. Choi, B.-K. Jeong, S.-H. Park, K.-H. Lee C52

Copper Barrier Properties of Low Dielectric Constant SiOCNH Film Deposited by Plasma-Enhanced CVD
Y. Shioya, T. Ishimaru, H. Ikakura, Y. Nishimoto, T. Obdaira, R. Suzuki, K. Maeda C56

Electrochemical Self-Assembly of $ZnO/SO_3EtPTCDI$ Hybrid Photoelectrodes
T. Oekermann, S. Karuppuchamy, T. Yoshida, D. Schlettwein, D. Wöhrle, H. Minoura C62

Morphology and Formation Mechanisms of Porous Silicon
X. G. Zhang C69

Integrated Electrochemical Deposition of Copper Metallization for Ultralarge-Scale Integrated Circuits
S.-Y. Chang, C.-W. Lin, H.-H. Hsu, J.-H. Fang, S.-J. Lin C81

Influence of the Surface Properties of SiC Particles on Their Codeposition with Nickel
M. Kaisheva C89

Direct Plating of Low Resistivity Bright Cu Film onto TiN Barrier Layer via Pd Activation
J. J. Kim, S.-K. Kim, Y. S. Kim C97

Electrochemical Synthesis and Engineering

Successive Hydrogenation and Dechlorination Systems Using Palladized Ion Exchange Membranes
C. Iwakura, Y. Tsuchiyama, K. Higashiyama, E. Higuchi, H. Inoue D1

Physical and Analytical Electrochemistry

Use of Underpotential Deposition for Evaluation of Overpotential Deposition Kinetics of Reactive Metals
E. Guerra, G. H. Kelsall, M. Bestetti, D. Dreisinger, K. Wong, K. A. R. Mitchell, D. Bizzotto E1

Ruthenium Oxide Thin Film Electrodes Prepared by Electrostatic Spray Deposition and Their Charge Storage Mechanism
I.-H. Kim E7

Electrochemical and Transport Properties of Templated Gold/Polypyrrole-Composite Microtube Membranes
K. Yamada, R. Gasparac, C. R. Martin E14

Kramers-Kronig Transforms as Validation of Electrochemical Immittance Data Near Discontinuity
A. Sadkowski, M. Dolata, J.-P. Diard, ... E20

Experimental and Theoretical Study of the Activity of Substituted Metallophthalocyanines for Nitrite Electro-oxidation
C. A. Caro, F. Bedioui, M. A. Páez, G. I. Cárdenas-Jiron, J. H. Zagal E32

Dielectric Science and Materials

Boron-Retarded Gate Dielectric Formed by Dry Oxidation of Thermal Nitride
Y.-H. Wu, C.-L. Ku, J.-F. Wang F1

Development and Characterization of a PECVD Silicon Nitride for Damascene Applications
A. S. Lee, N. Rajagopalan, M. Le, B. H. Kim, H. M'Saad F7

Semiconductor Devices, Materials, and Processing

A Simplified Picture for Transient Enhanced Diffusion of Boron in Silicon
M. Y. L. Jung, R. Gunawan, R. D. Braatz, E. G. Seebauer G1

Effect of Selected Ionic Inorganic Surface Contaminants on Thermal Oxidation of p-Type Polished Silicon Wafers
W. D. S. Scott, A. Stevenson G8

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Physical and Electrical Properties of Polycrystalline $Si_{1-x}Ge_x$ Deposited Using Single-Wafer-Type Low Pressure CVD
S.-K. Kang, J. J. Kim, B. G. Min, D.-H. Ko, C. W. Yang, K. Y. Lim G13

Characterization of Microstructure, Interfacial Reaction and Diffusion of Immiscible Cu(Ta) Alloy Thin Film on SiO_2 at Elevated Temperature
C. J. Liu, J. S. Chen, Y. K. Lin G18

Gas-Phase Mixing and Dispersion in a Diffusion Furnace
J. J. Biernacki, R. Subramanian, M. R. Islam, C. Schewe, M. C. Rogers G24

Hydrogenation Behavior of Yttrium Thin-Film Electrode in 1 M NAOH Electrolyte after Removal of Palladium Cap
E. Matveeva, V. Parkhutik G33

Transport Considerations in the Plasma-Assisted Oxidation of Copper Films
Y. Li, D. W. Hess G40

Ultrathin Strained Si-on-Insulator and SiGe-on-Insulator Created using Low Temperature Wafer Bonding and Metastable Stop Layers
G. Taraschi, A. J. Pitera, L. M. McGill, Z.-Y. Cheng, M. L. Lee, T. A. Langdo, E. A. Fitzgerald G47

Advanced Wet Cleanings Post-CMP
Application to Reclaim Wafers
A. Abbadie, F. Crescente, M. N. Séméria G57

Effect of Boron Dose and Post-thermal Budget on Electrical Properties of MOS-Capacitors with a W/WN_x/poly-$Si_{1-x}Ge_x$ Gate Stack
S.-K. Kang, B. Gi Min, J. Jin Kim, D.-H. Ko, H. B. Kang, C. W. Yang, T. H. Ahn G67

Physical and Electrical Properties of W/WN_x/Poly-$Si_{1-x}Ge_x$ (x = 0, 0.2, 0.6) Gates Stack with Post-thermal Process
S.-K. Kang, B. G. Min, J. J. Kim, D.-H. Ko, H. B. Kang, C. W. Yang, K. Y. Lim, T. H. Ahn G71

Etching of Silicon Native Oxide Using Ultraslow Multicharged Ar^{q+} Ions
V. Le Roux, G. Machicoane, S. Kerdiles, R. Laffitte, N. Béchu, L. Vallier, G. Borsoni, M. L. Korwin-Pawlowski, P. Roman, C.-T. Wu, J. Ruzyllo G76

Boron Profile Narrowing in Laser-Processed Silicon after Rapid Thermal Anneal
C. Hyia Poon, L. Seow Tan, B. Jin Cho, A. See, M. Bhat G80

Sensors and Displays: Principles, Materials, and Processing

$Li_{0.3}Sr_{0.6}B_{0.5}Ti_{0.5}O_3$ (B = Nb, Ta) and $Li_{0.3}Sr_{0.6}Ta_{0.5}Ti_{0.5-x}Fe_xO_3$ ($0 < x < 0.3$): Novel Perovskite-Type Materials for Monolithic Electrochromic Devices
V. Thangadurai, W. Weppner H1

Thermoelectric CO Gas Sensor Using Thin-Film Catalyst of Au and Co_3O_4
M. Matsumiya, F. Qiu, W. Shin, N. Izu, I. Matsubara, N. Murayama, S. Kanzaki H7

Effects of Chemical and Physical Agents on the Emission Properties of Alq_3 Films
G. Baldacchini, T. Baldacchini, A. Pace, R. B. Pode H11

Luminescence from Sol-Gel-Derived Europium-Doped Films Confined in Mesoporous Anodic Alumina
I. S. Molchan, N. V. Gaponenko, R. Kudrawiec, J. Misiewicz, G. E. Thompson, P. Skeldon H16

Structural Changes in Electrochromic WO_3 Thin Films Induced by the First Electrochemical Cycles
T. Pauporté, M. C. Bernard, Y. Soldo-Olivier, R. Faure H21

General Topics

Grain Boundary Space Charge Effect in Zirconia
Experimental Evidence
X. Guo, Y. Ding J1

***Ab Initio* Calculations and Structural Stability of Boron-Doped Sodium Manganese Oxide**
O. I. Velikokhatnyi, C.-C. Chang, P. N. Kumta J8

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Integrated Electrochemical Deposition of Copper Metallization for Ultralarge-Scale Integrated Circuits

Shou-Yi Chang,[z] Chi-Wei Lin, Hong-Hui Hsu, Jui-Hua Fang, and Su-Jien Lin*

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An electrochemical deposition process for copper (Cu) metallization has been developed and investigated by the integration of nanoscaled palladium (Pd) catalyzation, electroless plating of Cu seed layers, and electroplating of Cu films in this study. Following surface cleaning and etching, sensitization and activation of $Si/SiO_2/TaN$ substrates were performed to obtain uniformly distributed Pd catalysts of only about 10 nm. Smooth and continuous 30 nm thick Cu seed layers with low electrical resistivity were electrolessly deposited using the nanosized Pd catalysts as nucleation sites. Copper metallization with high purity, small surface roughness, low electrical resistivity of 1.77 μΩ cm, low residual stresses, and good adhesion to substrates was achieved using the subsequent electroplating on the electroless seed layers and postannealing. Good gap-filling capability on finely patterned structures was performed and exhibited the great application potential of low-temperature integrated electrochemical deposition process for next-generation Cu metallization of ultralarge-scale integrated circuits.
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As the packing density of semiconductor devices drastically increases, multilevel interconnection has been applied to compromise the insufficient surface area on integrated circuit (IC) chips. At the same time, the reduction in metal linewidths and pitches results in the rise of interconnect resistance and parasitic capacitance, leading to serious resistance-capacitance (RC) delay.[1,2] The RC delay has many drawbacks, especially the problem of low signal transmission speed, becoming the most difficult issue to overcome. Copper with lower electrical resistivity, high thermal conductivity, good mechanical properties, and high migration resistance has been used as interconnect metallization in dual-damascene structures of ultralarge-scale integrated (ULSI) circuits to replace aluminum and to directly reduce the metal line resistance.[3-5]

Copper metallization technology mainly includes traditional ULSI techniques such as physical vapor deposition (PVD) and chemical vapor deposition (CVD), or newly developed electrochemical deposition including electroplating and electroless plating.[6-23] The PVD method provides precise composition control but presents poor step coverage in deep submicrometer dimension features, resulting in problems like overhangs or voids.[6-8] Though CVD has better step coverage, its development is also limited because high processing temperatures and expensive equipment are required in addition to the combustible and toxic precursors.[9,10] Electroplating has the advantages of low processing temperature, low cost, high throughput, and good film quality, and thus becomes more attractive.[3,11-15] However, due to the need of sputtered Cu seed layers for electroplating, this deposition technique is inadequate for next-generation metallization below 90 nm. Recently, the deposition of uniform Cu seed layers only 20 nm thick into trenches or vias with good sidewall step coverage and a high aspect ratio of 10 has been developed using atomic layer deposition (ALD).[16,17] However, extremely expensive precursors and equipment are required for ALD, and it is still under investigation.

Electroless Cu deposition is a low-cost process of autocatalytic nucleation and growth at low temperatures without the necessity of electric power. It provides good gap-filling capability on finely patterned features and has been intensively studied as seed layers for Cu electroplating.[18-23] One of the most important factors to dominate the success of seed layer deposition is the uniform and nanoscaled catalyzation to activate the inert substrates prior to electroless plating. However, the discontinuity and high electrical resistivity of electroless Cu seed layers up to 6-8 μΩ cm caused by the incorporation of large-sized and high-resistance Pd catalysts renders its application limited, although much research of catalyzation mechanisms has been performed.[19,20,24-28] Hsu *et al.* have also developed several methods for catalyzation and electroless plating to obtain continuous Cu films with low resistivity, but all the thicknesses of Cu films are still too large for them to be used as seed layers for sub-90 nm metallization.[21-23]

Therefore, this paper reports the modified preparation of uniform, nanoscaled Pd catalysts by sensitization-activation of $Si/SiO_2/TaN$ substrates and the following electroless plating of thin, smooth, conformal Cu seed layers using the nanosized catalysts as nucleation sites. The subsequent electroplating was applied using electroless Cu seed layers to accomplish Cu metallization with good quality. A low-temperature and integrated electrochemical deposition process for sub-90 nm Cu metallization is thus proposed and summarized in this study. The microstructures and formation mechanism of Pd catalysts, electroless Cu seed layers, and electroplated Cu films were characterized and analyzed. Their purity, surface roughness, electrical resistivity, residual stresses, adhesion to substrates, and gap-filling capability were also investigated.

Experimental

Blanket and patterned 150 mm (100) silicon wafers with thermal oxide (SiO_2) layers 550 nm thick were used as substrates in this study. For patterned substrates, different features of trenches and damascene structures with various sizes of 0.18-0.35 μm were formed on the SiO_2 layers using standard photolithography and plasma etching processes. Tantalum nitride (TaN) layers 50 nm thick were deposited on these substrates as a diffusion barrier by dc magnetron sputtering. The TaN layers were identified as stoichiometric TaN 1:1 with (111) preferential orientation by Rutherford backscattering spectroscopy (RBS) and X-ray diffractometry (XRD). These $Si/SiO_2/TaN$ substrates were degreased and cleaned in acetone for 10 min under ultrasonic vibration and rinsed in deionized (DI) water after each step to remove residual chemicals.

The cleaned $Si/SiO_2/TaN$ substrates were chemically wet-etched using buffered oxide etchant/nitric acid (BOE/HNO_3) and hydrogen fluoride (HF, 10%) solutions at 35°C for 1 min to remove native oxides on TaN surfaces for easy catalyzation and good adhesion of catalysts. The etched substrates were then catalyzed in a sensitization solution composed of tin dichloride ($SnCl_2$, 10 g/L) and hydrogen chloride (HCl, 40 mL/L) at 25°C for 40 s, and then in an activation solution of palladium dichloride ($PdCl_2$, 0.25 g/L) and HCl (2.5 mL/L) at 60-80°C for another 40 s to deposit Pd catalysts.

The catalyzed $Si/SiO_2/TaN$ substrates were electrolessly Cu-deposited in the plating solution listed in Table I at a temperature of 50°C. Some minor surfactants like polyethylene glycol (PEG) were added to reduce the surface tension of plating solution and to improve the gap-filling ability.

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Table I. Solution composition for electroless Cu plating.

Component	Concentration
Copper sulfate, $CuSO_4 \cdot 5H_2O$	6 g/L
Ethylenediaminetetraacetic acid, EDTA	32 g/L
α,α'-Dipyridyl, $(C_5H_4N)_2$	100 mg/L
Potassium ferricyanide, $K_4[Fe(CN)_6]$	57.3 mg/L
Hydrogen chloride, HCl	1 mL/L
Formaldehyde, HCHO (37%)	7.5 mL/L
Sodium hydroxide, NaOH	pH 12.6
Polyethylene glycol, PEG (200)	0.5 g/L
Polyethylene glycol, PEG (2000)	0.5 g/L

Electrolessly deposited Cu films were used as Cu seed layers and subsequently dc electroplated in the solution listed in Table II at 25°C under different current densities. A copper plate of 5 × 5 cm^2 with a purity of 99.95% was set as anode to provide Cu ions. The electroplated Cu films were then annealed at different temperatures in an argon (Ar) atmosphere of 200 mTorr for 30 min.

A scanning electron microscope (SEM; Hitachi S4000) was used to observe the surface morphologies, cross-sectional microstructures, thickness, and gap filling of Pd catalysts and Cu films. The surface morphologies and roughness of as-received, catalyzed, and Cu-deposited substrates were examined by atomic force microscopy (AFM; Digital Instruments NS3a controller with D3100 stage) under a tapping mode. A transmission electron microscope (TEM; JEOL-2000FXII) with energy-dispersive spectrometry (EDS) and selective-area diffraction (SAD) analysis was used to examine the plan-view, cross-sectional microstructures, and composition of the deposited catalysts and Cu films. The depth profiling of the elemental distribution was analyzed by Auger electron spectroscopy (AES; AES670 XI), and RBS was also used to analyze the composition.

The XRD measurement (MAC MXP18 system) with Cu Kα radiation (1.5405 Å) and grazing-angle incidence (0.5°) was carried out to characterize the crystalline structure under a scanning speed of 4 °/min. The electrical resistivity of deposited Cu films was measured by a four-point probe method. The adhesion of Cu films to substrates was carried out using an ASTM tape test with 3M Tesa Tape and a peeling load of 500 g. Silicon cantilever beams of 4 × 0.4 cm^2, 140 μm thick were sputtered with TaN layers of 40 nm thick, Pd-catalyzed, electrolessly plated with 30 nm thick Cu seed layers, and electroplated with 270 nm thick Cu films for stress hysteresis measurement. Curvatures before and after Cu film deposition were measured using a laser ellipsometer to calculate the stress variation during thermal cycles from room temperature to 400°C.

Results and Discussion

Catalyzation of $Si/SiO_2/TaN$ substrates.—The purposes of chemical etching of $Si/SiO_2/TaN$ substrates prior to catalyzation are to remove the native oxides on TaN surfaces and to improve the sensitization and activation. Hence, both uniform removal of native oxides and mildly isotropic etching must be considered for the selection of proper chemical etching. Table III lists the average surface roughness of $Si/SiO_2/TaN$ substrates after different chemical etching conditions obtained by AFM surface scanning. Obviously, different surface morphologies with larger roughness were found after chemical etching. However, severely anisotropic etching by buffered oxide etch (BOE)/HNO_3/deionized (DI) water solutions resulted in excessively large roughness up to 2.17 nm from as-received 0.2 nm. Large roughness of the TaN barrier layers result in rough deposition of subsequent Pd catalysts and electroless Cu seed layers, and thus cause inhomogeneous distribution of electric field during Cu electroplating. With decreasing concentration of BOE/HNO_3, the roughness still remained at 1.15 nm. Using 10% HF as an etching solution, the roughness was only 0.23 nm, similar to that of the as-received sample and indicating the proper etching condition.

Table II. Solution composition for Cu electroplating.

Component	Concentration
Copper sulfate, $CuSO_4 \cdot 5H_2O$	30 g/L
Sulfuric acid, H_2SO_4	90 g/L
Hydrogen chloride, HCl	0.1 mL/L
2-Aminobenzothiazol, 2-ABT	50 mL/L
Polyethylene glycol, PEG (200)	0.5 g/L
Polyethylene glycol, PEG (2000)	0.5 g/L

Table III. Average surface roughness of $Si/SiO_2/TaN$ substrates after different chemical etching conditions.

Etching solution	Roughness (nm)
No etching	0.20
BOE:HNO_3:DI water = 1:1:2	2.17
BOE:HNO_3:DI water = 1:1:3	1.27
BOE:HNO_3:DI water = 1:1:6	1.15
10% HF	0.23

The preparation of small and dense Pd catalysts dominates the successful deposition of subsequently thin and continuous electroless Cu seed layers because Cu nucleates on these catalysts and then grows. Agglomeration of Pd catalysts causes insufficient and non-uniformly distributed nuclei for electroless Cu deposition and thus results in the discontinuity and rough surfaces of Cu seed layers. Besides, weak adhesion due to voids and defects between seed layers and substrates leads to film peeling.[29,30] Two typical catalyzation methods have been developed in our group: sensitization-activation and displacement-activation.[21-23] Smaller and denser Pd catalysts can be achieved by sensitization-activation and lead to continuous Cu films, fitting the request for Cu seed layers and being selected in this research.

Figure 1 shows the AFM 2D images of 75°C Pd-catalyzed TaN surfaces that had been previously etched with BOE/HNO_3/DI water

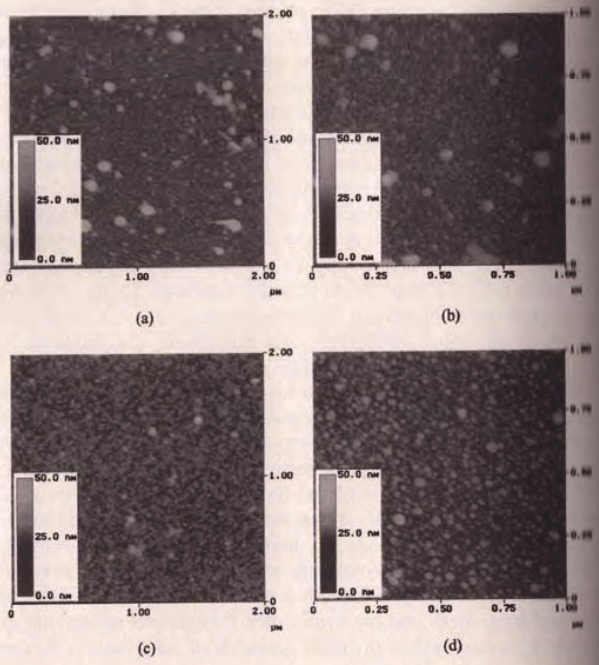


Figure 1. AFM 2D images of 75°C Pd-catalyzed TaN surfaces previously etched with (a) BOE:HNO_3:DI water = 1:1:2, (b) BOE:HNO_3:DI water = 1:1:3, (c) BOE:HNO_3:DI water = 1:1:6, and (d) 10% HF solutions.

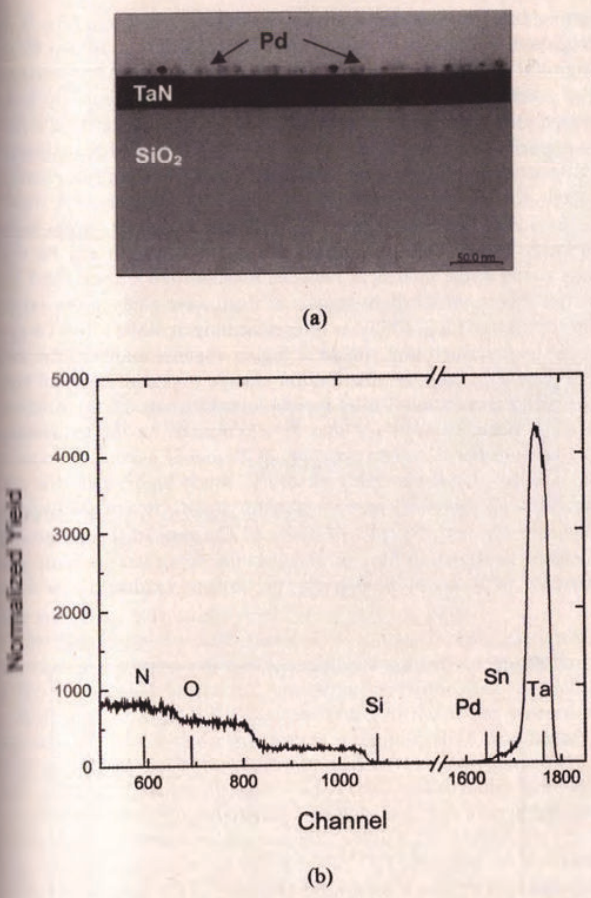


Figure 2. (a) TEM cross-sectional microstructure and (b) RBS spectrum of 10% HF-etched and 75°C Pd-catalyzed Si/SiO_2/TaN substrates.

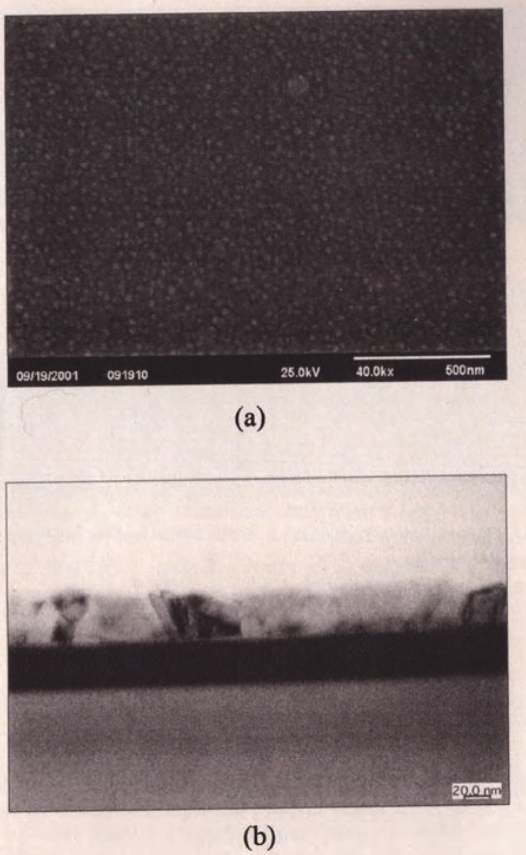


Figure 3. (a) SEM surface morphology and (b) TEM cross-sectional microstructure of electrolessly plated Cu seed layers on Si/SiO_2/TaN substrates previously 10% HF etched and Pd catalyzed at 75°C.

and 10% HF solutions for 30 s. After catalyzation, surface roughness increased because of the seeding of Pd catalysts observed. Although small Pd catalysts were obtained by using BOE/HNO_3/DI water etching, many large Pd particles precipitated, increasing surface roughness and reducing distribution uniformity. Using 10% HF etching and sensitization-activation, many uniform and dense Pd catalysts were obtained with 1.71 nm roughness, revealing the good quality of this catalyzation process. Figure 2a shows the cross-sectional TEM microstructure of 10% HF-etched and sensitization-activated Si/SiO_2/TaN substrates. Small deposited Pd catalysts of only about 5-10 nm were clearly identified with uniform distribution. The large amount of nanosized Pd catalysts seemed not to agglomerate but smoothly distributed to a single layer. With the adsorption of oxidized Sn^{4+} ions prior occupying the surface sites to lower interface energy during sensitization-activation, these Pd nuclei therefore stabilized at the scales of several nanometers under the equilibrium of surface, interface, and bulk energy.[23,31] Thus, in the deposited catalysts, Sn was incorporated into Pd catalysts, and the ratio of Pd to Sn was characterized as 4.6 by RBS analysis shown in Fig. 2b.

Electroless plating of Cu seed layers.—Figure 3a shows the surface morphology of 1 min electrolessly plated Cu seed layers on Si/SiO_2/TaN substrates that had been previously 10% HF etched and Pd catalyzed at 75°C. Under the contribution of well-distributed and nanoscaled Pd catalysts by sensitization-activation, continuous and smooth 20 nm thick Cu films were already obtained by electroless plating for just 1 min. Through nucleation, quasi-two-dimensional growth, and coalescence processes, the Cu deposits connected to each other and then thoroughly covered the substrates. The deposition process rapidly entered the final step, film growth. Figure 3b shows the cross-sectional microstructure of 1.5 min electrolessly plated Cu seed layers with a thickness of 30 nm. The Cu seed layers were constructed of small Cu grains of about 10-20 nm. Voids were neither found inside the seed layers nor between the layers and substrates. A few twins were observed in accordance with the much smaller twin-boundary energy than the grain-boundary energy.[20]

With increasing catalyzation temperature from 65 to 80°C, the nucleus density of Pd catalysts for electroless Cu deposition increased from the order of 10^3 to $10^4/\mu m^2$, and thus dense and smaller Cu grains formed. Because defects were more likely to exist in the films catalyzed at low temperatures, the Cu seed layers, therefore, exhibited lower electrical resistivity as the catalyzation temperature increased, as shown in Fig. 4. However, due to the much higher resistivity of Pd than that of Cu, the resistivity of Cu seed layers catalyzed at 80°C increased. Also, the resistivity of all seed layers was higher than 4.0 $\mu\Omega$ cm. Electrolessly plated 30 nm thick Cu seed layers on 10% HF-etched and 75°C Pd-catalyzed Si/SiO_2/TaN substrates exhibited small roughness of only 3.68 nm and the lowest electrical resistivity. They were selected as the seed layers for further Cu electroplating or even directly as sub-90 nm interconnect metallization.

The electrolessly plated 30 nm thick Cu seed layers were further annealed to verify their stability under thermal processes. Recrystallization, coalescence, and grain growth occurred in the annealed seed layers, associating with smoothened surfaces and unclear grain boundaries. With increasing annealing temperatures, grain growth

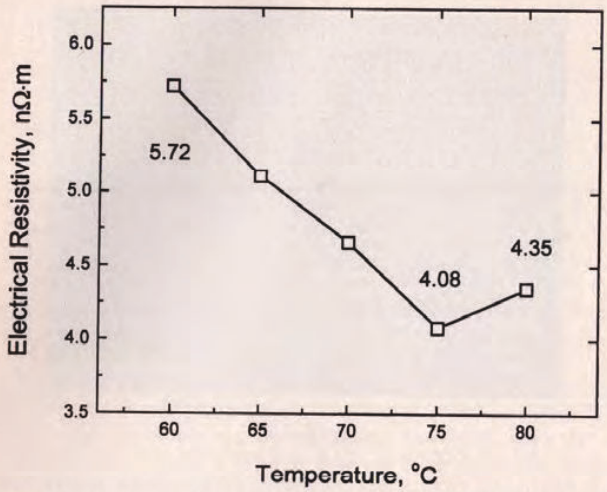


Figure 4. Electrical resistivity of electrolessly plated Cu seed layers on Si/SiO_2/TaN substrates previously 10% HF etched and Pd catalyzed at different temperatures.

and surface smoothening were more obvious. The grain size of as-deposited seed layers increased from 10 to 20 nm to 40 and 60 nm after 400 and 700°C annealing, respectively, from SEM observation. The corresponding AFM surface roughness of 400 and 700°C annealed seed layers decreased to 1.92 and 1.13 nm, respectively, from as-deposited 3.68 nm. Figure 5 shows the RBS and AES analyses of Cu seed layers after thermal annealing. The RBS signals of elements except Cu appeared at channel numbers lower than their regular channel edges because of the shielding effect of their depths below surfaces. From depth calculation, the components Sn and Pd were only found at the interfaces between as-deposited Cu seed and TaN barrier layers, while slight signals of them were analyzed to exist at the surfaces of Cu seed layers after annealing at 400°C. The Pd peak of the as-deposited film spread to higher channel number after thermal annealing, and the distribution change revealed the solid solution of Sn and Pd into Cu by typical interdiffusion. At this temperature, no penetration of Cu into Si was found. As the temperature increased to 600°C, slight amounts of Ta and N were even found at the surfaces. Until annealing at 700°C, much higher than the temperatures for practical barriers staying stable, severe diffusion of TaN into Cu and the interdiffusion of Cu and SiO_2 through TaN occurred as shown in Fig. 5d. Because the deposited Cu films were annealed in an argon atmosphere, no obvious oxidation was found

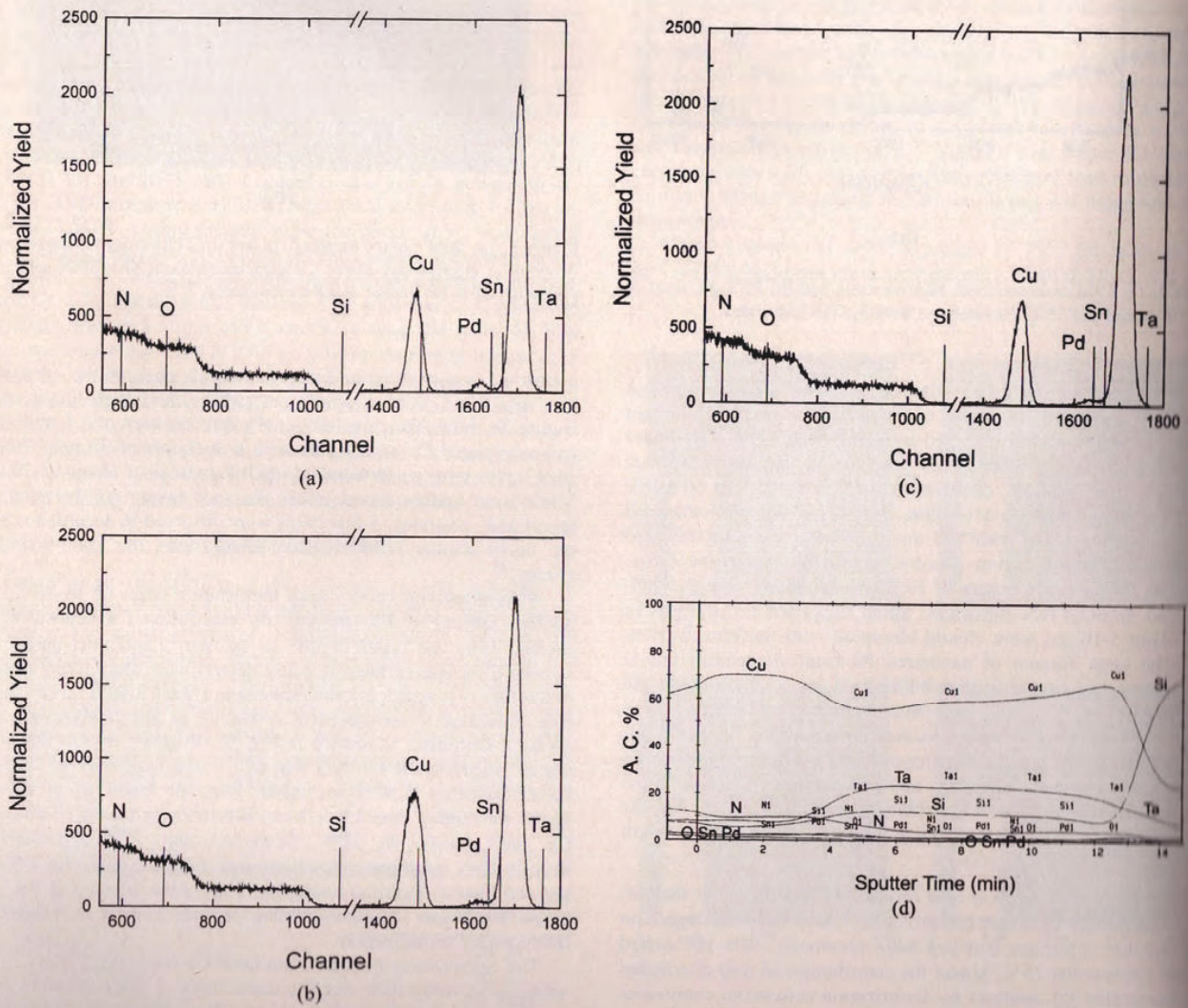


Figure 5. RBS spectra of electrolessly plated Cu seed layers, (a) as deposited and annealed at (b) 400 and (c) 600°C; (d) AES analysis of Cu seed layers annealed at 700°C.

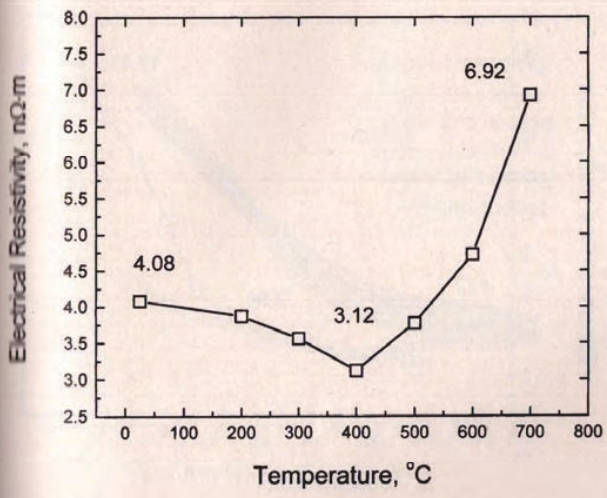


Figure 6. Electrical resistivity of electrolessly plated Cu seed layers annealed at different temperatures.

after annealing even under 700°C from AES analysis.

However, from the XRD patterns, no evidence of impurity interdiffusion or formation of new crystalline structure was found even in 700°C annealed specimens. The difference from what was found in RBS and AES analyses was attributed to the slight amount of impurity crystallites under the detection limit of XRD measurement. Besides, though the correspondence of Cu(111) facet to TaN(111) was expected because of their similar lattice constants, the XRD patterns exhibited no preferential orientation of electroless Cu seed layers. The measured peak intensity ratio I(111)/I(200) was 2.7, close to that under powder diffraction, 2.0. This might be attributed to the interference of Pd catalysts between Cu seed layers and TaN barriers. Less (111) preferential orientation would cause minor Cu stress migration.[32] Figure 6 shows that the electrical resistivity of electrolessly plated Cu seed layers decreased from 4.08 μΩ cm to the minimum value of 3.12 μΩ cm with annealing at 400°C. Grain recrystallization, coalescence, and growth reduced the amounts of defects and grain boundaries, accompanied by the elimination of residual hydrogen at these sites, thus reducing the resistivity. Though the interdiffusion of Sn and Pd with Cu occurred at 400°C from RBS analyses, the resulting slight increment in resistivity was compensated by defect elimination. With higher annealing temperatures, the resistivity drastically increased due to the interdiffusion of more impurities like TaN and even SiO_2.

Under the ASTM tape test, 60% of as-deposited Cu seed layers was found to peel basically due to the accumulation of hydrogen, and even bubbling or blistering, at interfaces between them and the substrates during electroless plating. However, no peeling of the seed layers occurred once they were annealed at 400°C, because defects like the residual hydrogen at interfaces were eliminated to enhance the bonding of seed layers to substrates, achieving higher adhesion strength. Figure 7 shows the surface morphologies of 1.5 min electrolessly plated Cu seed layers on patterned $Si/SiO_2/TaN$ substrates with different-sized features. One of the most important advantages for using electroless Cu deposition as seed layers is its excellent step coverage in these deep submicrometer features because of the uniform nucleation and growth of Cu on nanosized Pd catalysts. Electroless plating provided excellent sidewall step coverage similar to bottom step coverage with the same Cu seed layer thickness.

Electroplating of copper films.—To evaluate the feasibility of integrated electrochemical deposition, 1.5 min electrolessly plated, 400°C annealed Cu seed layers with a thickness of 30 nm were used for subsequent Cu electroplating. Attributed to the good uniformity of seed layers, smooth surfaces of electrodeposited Cu films were

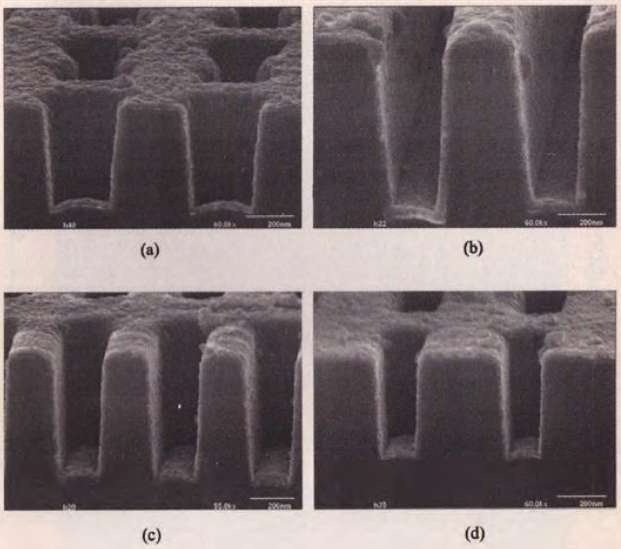


Figure 7. SEM surface morphologies of electrolessly plated Cu seed layers on patterned $Si/SiO_2/TaN$ substrates with different-sized features: (a) 0.35, (b) 0.25, (c) 0.20, and (d) 0.18 μm.

obtained under current densities of 1-4 mA/cm^2, as shown in Fig. 8a and b. The thickness of 5 min deposited films under a current density of 3.33 mA/cm^2 was about 180 nm, equivalent to a deposition rate of 36 nm/min. Though larger current densities than 4 mA/cm^2 contributed higher deposition rates, as shown in Fig. 8c and d, loosely packed rough films precipitated at local sites where the solution concentration was not uniform due to the rapid consumption and insufficient supply of Cu^{+2} ions. The same results were also observed from AFM images. As shown in Fig. 9, the surface roughness of Cu films decreased and reached the minimum value of 5.47 nm as the current density increased to 3.33 mA/cm^2, and then large precipitated particles increased the surface roughness as the current density exceeded 3.33 mA/cm^2.

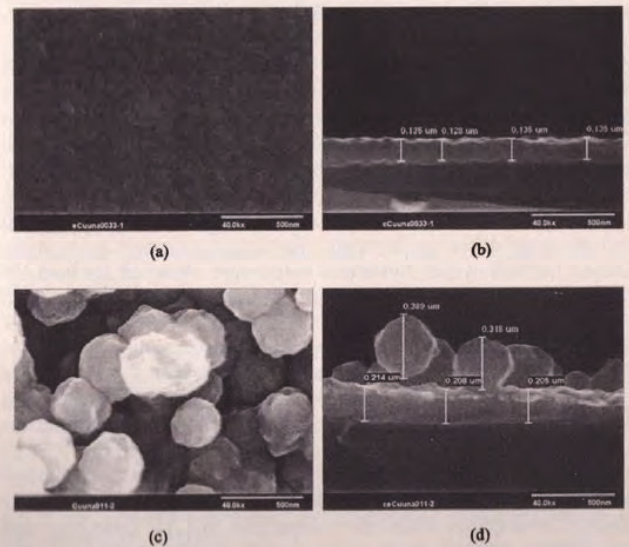


Figure 8. SEM (a) surface morphology and (b) cross-sectional microstructure of electroplated Cu films under a current density of 3.33 mA/cm^2; (c) surface morphology and (d) cross-sectional microstructure of electroplated Cu films under 11 mA/cm^2.

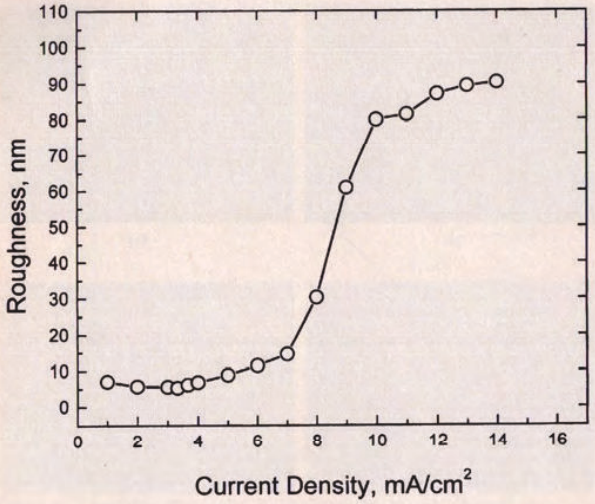


Figure 9. Average surface roughness of electroplated Cu films under different current densities.

As a result of surface roughness, the electrical resistivity of 180 nm electroplated Cu films, shown in Fig. 10a, reached a minimum of 2.32 μΩ cm under a current density of 3.33 mA/cm^2. Thicker films of 1900 nm obtained by a longer plating time of 1 h even exhibited lower resistivity of 2.04 μΩ cm. Figure 10b shows the electrical resistivity of electroplated Cu films after thermal annealing at different temperatures. The resistivity of 180 nm and 1900 nm Cu films after annealing at 400°C was further lowered to 2.14 and 1.77 μΩ cm, respectively. The values were much closer to that of pure Cu, 1.68 μΩ cm, because of the elimination of defects and grain boundaries associated with the release of adsorbed hydrogen. Similar to Cu seed layers, the interdiffusion of impurities drastically increased the resistivity under higher annealing temperatures. However, from the XRD patterns, no evidence of impurity interdiffusion or formation of new crystalline structure was found due to the small amount of impurity crystallites.

Thermal stresses form during thermal processes and remain at room temperature due to the difference in coefficients of thermal expansion (CTEs) between different materials.[33] Different processing methods lead to different thermomechanical behaviors of materials. Figure 11 shows the stress hystereses of electroplated Cu films using electrolessly plated and sputtered Cu seed layers during three thermal cycles. The as-electroplated Cu films using electroless Cu seed layers exhibited smaller residual tensile stresses of about 80 MPa because of the low-temperature integrated electrochemical process. Using sputtered seed layers, the residual tensile stresses were much larger, about 150 MPa, due to the strong radical bombardment and the large difference between sputtering and room temperature. During thermal cycles, hysteresis loops were observed for both Cu films. With increasing temperature, residual tensile stresses were eliminated and then compressive stresses piled up due to the larger CTE of Cu than substrates. As the temperature reached about 250-300°C, Cu started to yield and thus the compressive stresses were released. At 300-350°C, stress-induced Cu recrystallization and grain growth occurred and then reduced the sites for yielding dislocations to sink, so compressive stresses stabilized. Above 350°C, compressive stresses released to zero due to easy Cu yielding/softening under high temperatures. During cooling, tensile stresses slowly accumulated under the competition of CTE difference and Cu yielding. Because the dissolution of Sn and Pd catalysts into Cu films at high temperatures resulted in a strong solution-strengthening effect, the yield strength of Cu films using electroless seed layers was highly enhanced. Therefore, as the temperature was lowered to 250°C, Cu yielding gradually ended and then tensile stresses rapidly

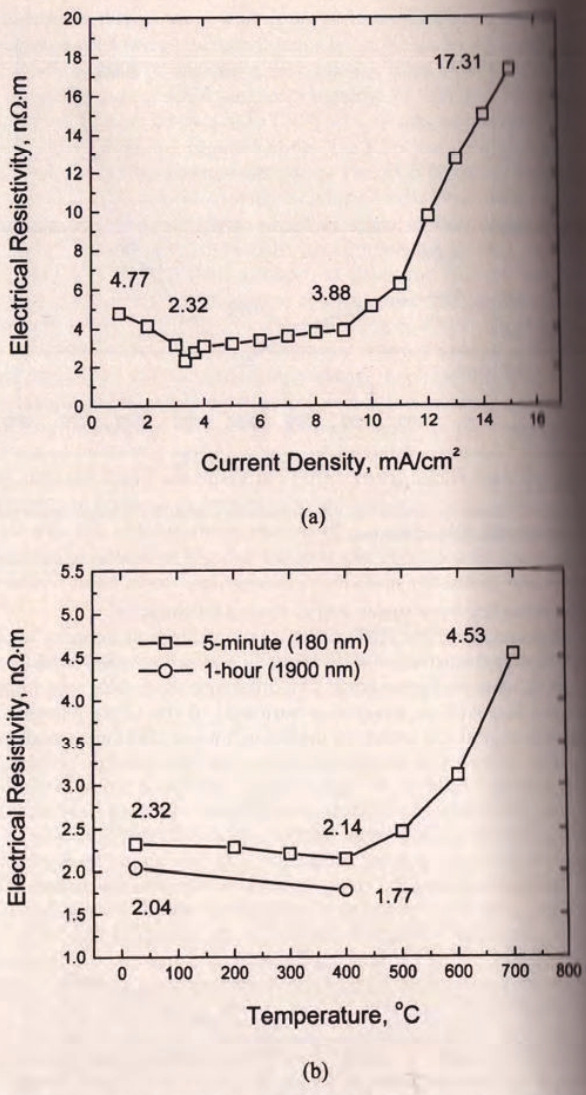


Figure 10. Electrical resistivity of electroplated Cu films, (a) deposited under different current densities and (b) annealed at different temperatures.

increased. Stress hystereses with narrow loops during second and third thermal cycles located at 150-400°C. In comparison, the yield-ending temperature for those using sputtered seed layers was lower than 200°C, and the wide hysteresis loops surrounded at room temperature to 400°C. The high mechanical strength of the Cu films using electroless Cu seed layers would achieve higher thermomechanical stability of patterned structures during thermal processes. Although the residual stresses of the Cu films using electroless Cu seed layers after thermal processes were slightly higher than those using sputtered seed layers and might cause the Cu metallization to a more tensile state, during cooling to temperatures around 200°C at which stress migration would most probably occur,[32] both stresses of the films using different seed layers were at the same level of about 100 MPa.

20% of electroplated Cu films peeled under an ASTM tape test, however, only around specimen edges due to some cutting defects and etching of acid plating solution. Similarly to electrolessly plated Cu seed layers, 100% electroplated Cu films passed the peeling test after annealing at 400°C. Using electroless seed layers, excellent superfilling of electroplated Cu films was also achieved on patterned Si/SiO_2/TaN substrates with different-sized features including 0.18

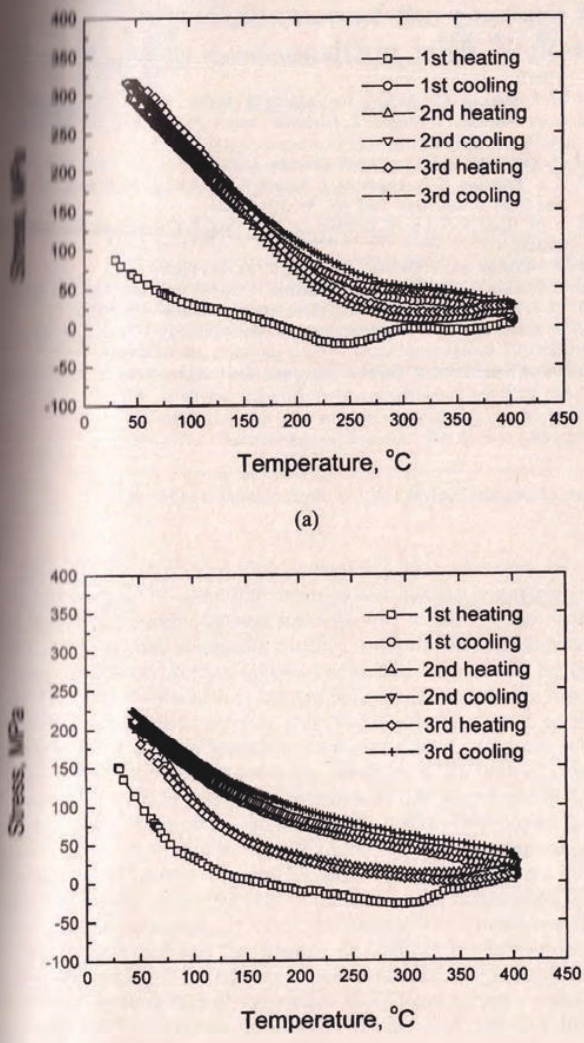


Figure 11. Stress hystereses during three thermal cycles of electroplated Cu films using (a) electrolessly plated and (b) sputtered Cu seed layers.

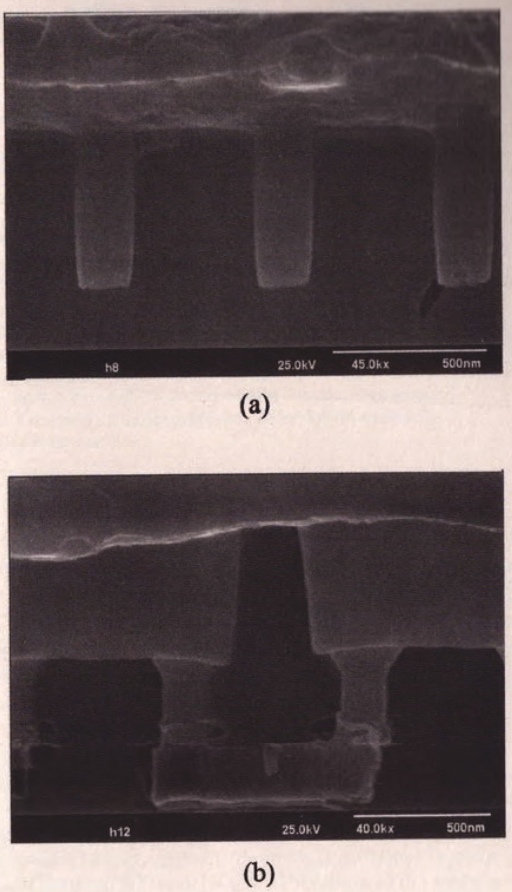


Figure 12. SEM cross-sectional microstructures of electroplated Cu films on patterned Si/SiO_2 /TaN substrates with different-sized features: (a) 0.18 μm trenches and (b) dual-damascene structures.

μm trenches and dual-damascene structures as shown in Fig. 12. Because of the advantages including small surface roughness, low electrical resistivity, low residual stresses, good adhesion to substrates, and excellent gap-filling capability, the application potential of low-temperature integrated electrochemical deposition process constructed of nanoscaled Pd catalyzation, electroless plating of continuous Cu seed layers, and electroplating of smooth Cu films for ULSI sub-90 nm interconnect metallization is thus highly predicted.

Conclusions

A low-temperature electrochemical deposition process for sub-90 nm Cu metallization was developed by integrating nanoscaled Pd catalyzation, electroless plating of Cu seed layers, and electroplating of Cu films in this study. First, uniformly distributed Pd catalysts of only about 10 nm were obtained by 10% HF etching and sensitization-activation of Si/SiO_2 /TaN substrates. Second, electroless Cu plating on these nanosized Pd catalysts was applied to obtain smooth and continuous 30 nm thick Cu seed layers with low electrical resistivity and good step coverage. Last, Cu metallization with high purity, small roughness, low electrical resistivity, low residual stresses, good adhesion to substrates, and excellent superfilling was achieved using electroplating on the electroless Cu seed layers. Thermal annealing at 400°C further reduced the electrical resistivity of Cu films to 1.77 μΩ cm with minor impurity interdiffusion. Associating with good gap-filling capability into small-sized features including dual-damascene structures, the great properties of the integrated electrochemically deposited Cu films render this process highly promising to next-generation Cu metallization for sub-90 nm ULSI circuits.

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