

'LDQH 5HQGHU 7HPHVJHQ 6DPXHO +RZDUQL.LQJ 0DG
5DPDSXUDP -D\DFKDQGD %DEX DQGLYHGD&D G DIXDU
&DUERQDWH 1DQRSDUWLF0HVRIXUQ(COVRIU L B Q B R D WHOU
\$UWLFOH , ' WWS S G J H V R K R U J
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9LMD\D . 5DQJDGLJ%LHRIQ Q VSDORHF RUPSRD\$DMLXVHLQJ K
V\QWKHVLJHG IURP HJJVKH-QXZDVOV RIDS\$G\$VRH\$URVH
6FLHQFH LQ SUHV
0XKDPPDG \$,PDP 0 * *RPHV (HVSHULGLDQD \$ % 0F

9LWXV \$SD9LMDVD 5D2RQULDFH 7LLPREQG6KBNV-JHQ
6DPXHO 3'HYHORSPHQW RI DQWLPLF

QDQRFPSRVLWHV -RXUQDO RI \$SSOLHG 3RYOH BHU 6F SDJH DUWLFOH

1\GHL D : %RLOMCHQ . 5DQJ B K DLN -HHODQL 6H\KDQ %R 6KUH 566Q\K KVLV DQG H WLOFXQ D\QR S DRUW D Q Q HV IRU DSSOLF B W U R Q Q R IO Q D Q R S L D U W L F D S S 7DULJ \$ 9DMDDQ 5DQKDUN -HHODQL 6RQRFKHPLFDO &KDUDFWHUL]DGLR\G URR [%LSD W D W H Q W D Q R I S D Q R W D R Q H V %LRPDWHULDOV ,Q SUHV

9LMD\D . 5DQJ B K DLN 6DPVXU D Q G H K D Q N F - D H O W Q H U P D FRQGXFWLQJ SURSRU G W L H U D B D & O A V P V O L R X W Q Q D Q R I L O \$SSOLHG 3RO\PHU 6FLHQFH ±

:LOOLDPV 7 +RVXU 0 7KH 5RGRJCHU LH 19OHVQWLD YDOLPH \$ (IIFWV RQ 0RUSKRORJ\ DQG %RQGLQLE \$ BVOIRW\ LQ 0H &RPSRVLWH 5HLQIRUFRPHQ WR X U Q M D B R I D 3 Q C S P H V V 6 F L H -LWHQG GHU 0DGDQ X%KSDW L W I %JDUXDMX D O R K D D P & C D 2W \$ Q <DWHV 7LPR 9LMDAX 5DQJ B K DLN D O G +DPHOEHUJ DQG 5LWX 0ROHFXODU &\FORH Q I Q M S W X B D W E R Q L W X I J P D S H X P S L F R , Y H G RI %URPLQDW H G 3 I R W F D S W Q M & I P D a f m a t e u s c i O O V S S

± 9LMD\D . 5DQJ B K DLN 6DPVXU %KX D Q Q & R P L S D U H W Q Y H V W X P L F U R Z D Y H D Q G W K H U P D O F X U L Q J R I P K I U J K W H P S H U D V QDQRFPSRVLWHV D, Q Q W L K Q H L W L S R O F S H U R X L H Q D O R I 1 D C

9LMD\D . 5DQJ B K DLN 6DPVXU %KX D Q Q 6KDFLNR ZIHYE FXULQJ &1)V (321 QDQRFPSRVLWHV W H I V P D O G D W Q B S P H U F W K I D H Q L F D O &RPSRVLWH \$ 0XMLEXU 5 .KDQ +DVVDQ 0DK B X I M D Y K H R G 5 R U D G D W Y L H Q W \$ Q G U H D V . \ U L D F R X (M K B Q D I R Z J G W R X Q U W Q H S B O H Q W K X O H W K U R X J K L Q I X V L R Q U F I R R X O D V L E Z V Q E F R Q D I G S O X D W Z H D K I K M S R O \ H W K R O H Q H U (Q J L Q H H U L Q J 6 F L H Q F H ±

2 0DONLQD + 0DKIX]9LMD\D 6RUJ 5DQJ B K DLN U R S L F S K I \ S U R S H U W L H V R I 6 & H S R [\ U H L Q I R U K F C H G H U Z L X Q K L I R D J P D J Q H W L - F 0 I D W E G 6 F L ±

9LMD\D . 5DQJ B K DLN 6DPVXU < 6KDLN *KRXVH 0 0RKDPPDG 5HLQIRUFHPHQW RIOHLV 1LQQ B R Q S S U R S L F L O V Q M K V R Q J K H P H I C H [W U X V L R Q S U R F H V V - P X Q C Q D Q H L I U \$ S S B S H G W B I R O X P H U 6 F

± 5DQJ DUL 9LMD\D 6DPVXU *KRXVH -HHODQL 6KDLN %X 9LQRG 6\QWKHVLV DQG FKDUDFWHUL]DGLR\G H R W G U H L Q I R U F H P H Q W L Q \$ & C R S S O L H G O D W L E W I L D O V , Q W H

± .RPDO 9LJ 6H\KDQ M P R D R 5 D Q J B K DLN H O 0 L O O H U 6 K U H H N 6KUH 5 6LQJK 5HWSDOD 9LQXV 6, Q W F B S B W W R Q H Z L W V 7UDQVPLVLRQ (OHP\LRBQ \ V L F D R V F R S \ 6 X S S O H P H C

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1DQRFPSRVLWH 7DQQDUQP\$ 9D.LG\$03(60DNHODQL
/RQJ %HDFK &\$
0HWDO DQG PHWDOV WYKGHUFBSVOIGHBWDRCV LQ WKHU
WKHUPRSODVWLF SRO\PHDQFBLWD\DH\ 5DRKDRD G *H
6KDLN -HHODQL &QWHUHQDVFHRQDQBJEBCRWBQWWDHOK
&KDOOHQJHV ,GGZDQK,QRWRJWXVGSXHU,1', \$ 'HFHP
6LJH 5HGXFWRQ RIV(JJKH(HOEF3DQWDECHORQDFDLWR
7LPH 9DULDWLRQ 9+D5DQDGL-HHOSGL)50.05DQDWQ
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:DVKLQJWRQ 6WLDVQH&&FRQWHLQ 6HDWWOH :\$
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'HFRUDWLRQ RI \$OH&X RQDQSDMLZDQVHGDGDUVERIQLQDC
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-HHODQL 056 6SULQJ \$DQLQDQFLVFR &\$
6\QWKHVLV)DEULFDWLRQDQKFDQD&KIDUDFWHWHQJDWL
%DVHG %LR 1DQRERF&SRWLDVQH9LMD\DKD5DJDIDQDQG
*RUGRQ 5HVHDFK &RQIHUHGFH ± &RPSRVLWLVH&\$ -DQ
6\QWKHVLV FKDUJDFWVHLSBIDLSRO/RAFRP 7DULJ \$
:ULJKW %ROGHQ -H5DQJDUL 6 %R\RJGRQ 5H%BB&FK*R
&RQIHUHGFH ± &RPSRVLWLVH -DQXDU\ 9HQV
)DEULFDWLRQDQKFDQD&KIDUDFWHWHQJDWL
PXOWLIXQFWLRQDSSOLFDWLRQKDNM-DHODQDQJDQJ
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1DQRSDUWLFQHV \DDU5DJQDUMDDQ9LMD\NDQDODQ
0HHWLQJ 1RY 'HF %RVWRQ 0\$
)DEULFDWLRQDQKFDQD&KIDUDFWHWHQJDWL
)LEHUV 9LMD\D . 5DQJDUL 0 *KRXVWLRQDQDQ -HHOD
0HFKDQLFDO (QJLQHHLQJ &RQJUHVMNHI[SRVHLQDLRQ
9LVD)/
*URZWK PHFKDQLVPQRI QD&QIRSDXWLLFQMDADV FDWDOV
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'HODZDUH 'HODZDUH
6\QWKHVLV &RPSDUDWLYH 6WXG\RIQKH&P)DQDQG
1DQRFRPSRVLWLVH 9LMD\D . 5DQJULODQDLP, &B 6 %
WK, QWHUQDWLRQDQD&KIDUDFWHWHQJDWL -XO
(GLQEXUJK ,QWHUQDWLRQDQD&KIDUDFWHWHQJDWL (GLQEXUJK 8
6\QWKHVLV RI GUXJQDQD&KIDUDFWHWHQJDWL 9LMD\DQDQDQ
-HHODQL ,&&0 RQDQ, QWHUQDWLRQDQD&KIDUDFWHWHQJDWL
-XO (GLQEXUJK ,QWHUQDWLRQDQD&KIDUDFWHWHQJDWL

8.
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(JJVKHOO 9 5DQJDUL 97 . \$ 5DQJDQ 03(6 1 -HHODQL
&RQIHUHGFH DQG ([KLELWLRQ %DOWLPRUH 0DU\OD

6\QWKHVLV DQGR&KFDU'DXW HFRD]D W G D B O Q H W B F 51DQJDS
1 : %ROGHQ 9 . -H B Q D D W L 6\$03(¶ D Q & R Q K L U E H W E I R C
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6LOYHU &RDWHG &KWERQ 5DQ R Q M X I E W L R Q X E / E \$ G D D Q L
6 %R\RJOX . 9LJDQJ B U Q O B L 5 96L&RQ I H D Q R W H F K
([SR *HRUJH 5 %URZQ 80RQ Y H Q W L R Q & R X I V W R H Q 7;
5HVSLUDWRU\ 6,\QFL W L W D R Q L E X V R O R S D Q G W L F W D I Q L X P 9
6 %R\RJOX 9 5DQ 6 D U L 6 L Q J K L Q D D Q R F H F K [& R Q I H U H
*HRUJH 5 %URZQ & R Q D H Q W L R Q & + R Q W W R Q 7;
\$QWLPLFURELDO H S U R S H D W M I G H & 1 R I V E S D X K R \ D Q 3/ 6 X
\$GLDQL 6 %R\RJOX * 0R K D P P D G 96L5DQJ K J D 6 U L 3 L Q O D
1DQRWHFK &RQIHUH Q F H ([SR *HRUJH 5 %URZQ & R Q
+R X V W R Q 7;
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6RQRFKHPLFDO PHWKR G 7 \$ + D V V D R Q W H F K 5 D Q J D U L
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7;
6\QWKHVLV R I % L R W & H D O B Q R F S & D W E R Q B Q R V 6 U J N K 5 H C O X
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6 K U H H 5 D P 6 L Q J K D Q G 6 K U H H N X P D U 3 U G 0 B Q W R B R H L

WKH .H(\$QQXDO)RUFH +HDOWK 3URWHFWLRLR & RQIHU
& HQWHU \$OEKZ XHHUTFR 1 \$XJXVW
& KDUDFWHUL]DWLRQ DRW HULLDORFR RSRVWEMSO HFWURQ PL
9 . 5DQJDUL 0 < 6KDLN DQG 6 -HHVDQL 0LFURVFRS
0HHWLQJ \$XJXVW TXH & RSOYHQTW HRQH & FTQ W/HUH \$OE
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6\QWKHVLV RI PDJQHWDQGDWRSDSUSOLEFDYWHUR QMVLQHG
:ULJKW %ROGHQ 9 Tuskegee University, US, NSTI, Q L
NanotechJune 1-5, Boston-2008,
(YDOXDWLRQ RI 1DQRHQFDSVXODWHG.'1\$L9D9FLQH IF
5DQJDUL 6 3LOODL Alabama State/University, US, NSTI,
NanotechJune 1-5, Boston-2008,
8VH RI 1DQRSDUWIRFU 5HVVSUUTKWRD'S QKLE\WWLIDROQ 9.L U9X
6 %R\RJOX 9 5DQJDLQJK/ 6XQL OSADamaState 6LQJK
University, US, NSTI, NanotechJune 1-5, Boston-2008,
7KHUPDO DQG 0HFKDQLFDO 5HVSRRQVHGRIE 026 6RDRPDW
FRUH PDWHULDQV. :5'DQRDUHUTuskegeeUniversity, US,
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, Q VLWX V\QWKHVLV IRX QO&1QFSXVULVLIJ 0DFGLRZVLYRQ
9 . 5DQJDUL 6 ' Tuskegee University, US, NSTI, NanotechJune 1-
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,QYLWHG 7DONV 1DWLRQDO DQG ,QWHUQDWLRQDO

,QYLWHG 6HPLQD E DOWHFRQX D G R Q U N D E H B W Q H & M 7 M R Q V L
ZRYHQ FDUERQ ILEHW DMS & RUO D P L O O B W P L Y Q W V R L I W) L E ' H S
6FLHQFH DQG \$SSDUHO^{WK} 'HVLJQ RQ 6HSW
,QYLWHG OHFWXUHUR%QLR P Q S S D D W L S S H W K B S L R Q V D V
\$GYDQFHV LQ MCKWLRQHWRFUKQRORJLQ QGL QDXRWHFKG

.H\QRWH OHFWX~~B~~ND~~M~~R~~S~~GRQ 816~~Z~~RWHF~~Q~~Q~~Q~~Q~~Q~~Q\ DSS
,PSOLFDWLRQVH,~~R~~IG~~&~~~~D~~IP,~~L~~F~~V~~~~L~~~~T~~~~H~~~~F~~~~M~~~~Q~~R~~I~~RRYJ\ +\GHUDE
,QYLWHG VHPLQDUL~~D~~W \$~~R~~EX~~P~~~~E~~U~~Q~~Q~~Q~~Q~~H~~Q~~L~~E~~H~~H~~S~~~~D~~Q~~W~~L~~P~~~~H~~Q~~M~~
6HPLQDU RQ 3RO\PHU 1DQRFR~~P~~^W~~S~~RVLWH 0DWHULDOV