*Advanced Photonic Technology Lab, College of Electronic and Optical Engineering, Nanjing University of Posts and Telecommunications, Nanjing 210023, China*

*&RUUHVSRQGLQJDXWKRU=X[LQJ=+$1*DLO[]KDQJ#QMXSWHGXFQ*

*$EVWUDFW7KLJKVHQVLWLYLW\ WHPSHUDWXUH VHQVRU EDVHG RQ WKH KLJKHU RUGHU PRGH RI WKH PLFURVSKHUH*
*DQGYHULILHG E\H[SHULPHQWDO VWXGLHV RQ DQ DFLQWHUIHURPHWHU FRQVWUXFWHG IURP WZR VHFWLRQV RI SRODUL]DWLRQ PDLQWDLQLQJ ILEHUV 30) VHQVRU ZLWK DQ LQWHUVHFWLRQ DQJOH RI I EHWZHHQ WKH LUIDVW D[HV 7KH KDUPRQLF 9HUQLHU GHYLDWLRQ WKHRU\ RI WKH HQJWKRI RQH RI WKH 30) VDQLQWHJUDOPXOWLSOH RI WKH HOHQJWKRI WKH RWKHU RQH WKH6DJQDFLQWHUIHURPHWHU EDVHGRQ WKH IXQGDPHQWDO 9HUQLHU HIIHFW LV KLJKHU WKDQ WKH IXQGDPHQWDO 9HUQLHU HIIHFW WKHRUGHU RI WKH KDUPRQLF*

*.H\ZRUGV +DUPRQLF9HUQLHUWHPSHUDWXUHVHQVRUSRODUL]DWLRQGDWDQGDQWLQWHUIHURPHWHU*

*&LWDWLRQ0HLDQ%HLEHL=+8DQG=X[LQJ=+$1*³+LJK6HQVLWLYLW\7HPSHUDWXUH6HQVRU%DVHGRQ+DUPRQLF9HUQLHU(IIHFW Photonic Sensors*

## ,QWURGXFWLRQ

2SWLFDO ILEHU VHQVRUV KDYH WKH DGYDQWDJHV RI +RZHYHU WKH DERYH WZR VWUXFWXUHV DUH QRW VXLWDEOH IRU 6DJQDF LQWHUIHURPHWHU EDVHG WHPSHUDWXUH VHQVLQJ DQG VPDOO VL]H 7KH\ DUH ZLGHO\ XVHG LQ WHPSHUDWXUH VWUDLQ SUHVVXUH PDJQHWLF ILHOG DQG RWKHU VHQVLQJ ILHOGV >±@ ,Q RUGHU WR LPSURYH WKH SHUIRUPDQFH RI RSWLFDO ILEHU VHQVRUV PDQ\ UHVHDUFKHUV KDYH FRQGXFWHG D ORW RI UHVHDUFK RQ VWUXFWXUH DQG PDWHULDOV RI RSWLFDO ILEHU VHQVRUV >±@

5HFHQWO\ UHVHDUFKHUV KDYH IXUWKHU LPSURYHG WKH VHQVLWLYLW\ RI VHQVRUV E\ DSSO\LQJ WKH RSWLFDO 9HUQLHU HIIHFW >±@ )RU H[DPSOH 6KDR et al >@ SURSRVHG D WHPSHUDWXUH VHQVRU EDVHG RQ WZR 6DJQDF LQWHUIHURPHWHUV 6,VDQG WKH VHQVLWLYLW\ RI WKH VHQVRU FDVFDGHG E\ )DEU\3HURW LQWHUIHURPHWHU ZDV DERXW WLPHV KLJKHU WKDQ WKDW RI D VLQJOH 6DJQDF LQWHUIHURPHWHU 6LPLODUO\ D WHPSHUDWXUH VHQVRU EDVHG RQ WKH 9HUQLHU HIIHFW >±@ KDV EHHQ SURSRVHG DQG LWV VHQVLWLYLW\ LV DERXW WLPHV KLJKHU WKDQ WKDW RI WKH 6DJQDF LQWHUIHURPHWHU )3, DQG 6, DQG WKH 9HUQLHU HIIHFW LQFUHDVHG WKH VHQVLWLYLW\ E\ DERXW WLPHV +RZHYHU WKH DERYH WZR VWUXFWXUHV DUH QRW VXLWDEOH IRU 6DJQDF LQWHUIHURPHWHU EDVHG WHPSHUDWXUH VHQVLQJ DQG VPDOO VL]H 7KH\ DUH ZLGHO\ XVHG LQ WHPSHUDWXUH VWUDLQ SUHVVXUH PDJQHWLF ILHOG DQG RWKHU VHQVLQJ ILHOGV >±@ SURSRVHG D WHPSHUDWXUH VHQVRU EDVHG RQ WKH IXQGDPHQWDO 9HUQLHU HIIHFW WKHRUHWLFDOO\ DQG YHULILHG WKDW WKH DPSOLILFDWLRQ RI WKH WHPSHUDWXUH VHQVLWLYLW\ RI WKH 9HUQLHU HIIHFW LV DERXW WLPHV KLJKHU WKDQ WKDW RI WK

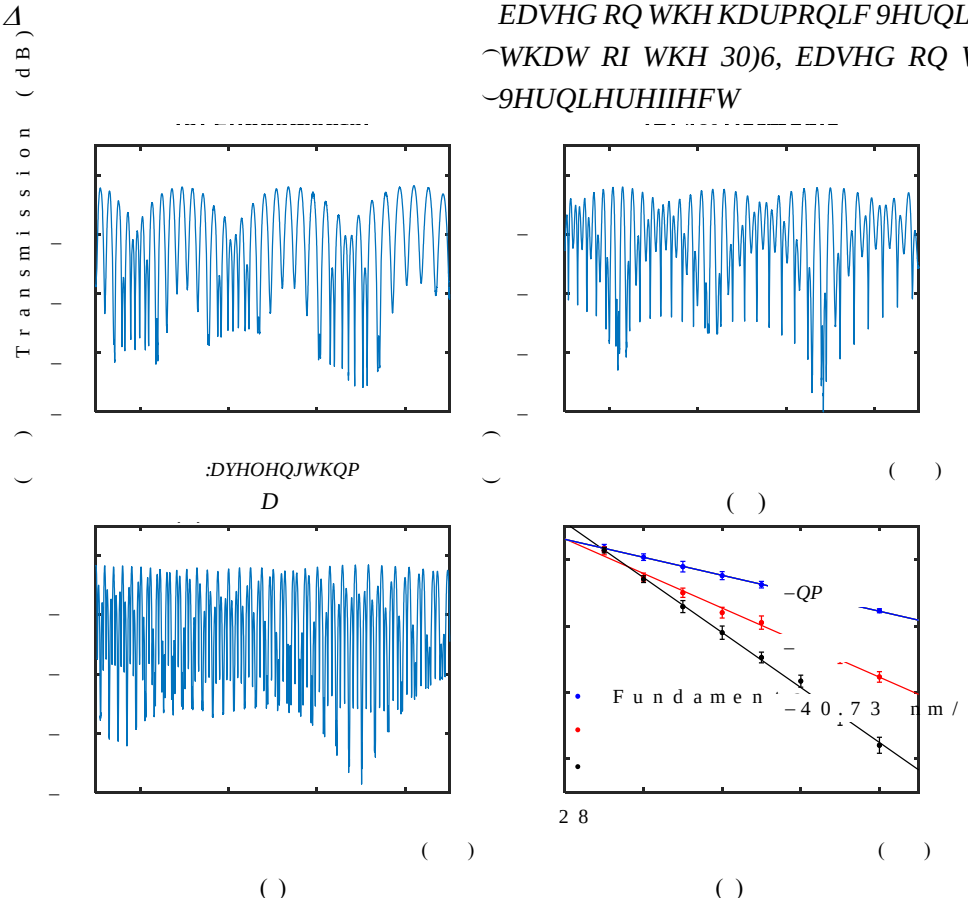


Fig. Transmission spectral evolution of the first-order and second-order resonances; temperature response and sensitivity.

## 4. Conclusions

In this paper, we proposed a PMF-SI sensor based on the harmonic structure of the PMF-SI is

IDFWRU DUH VSOLFHG ZLWK DQ LQWHUVHFWLRQ EHWZHHQ WKH LUIDFH[HKDUPRQLF9HUQLHUHIIHFW LV UHDO]HG LQ WKLV VWUXFWXUH WR HQKDQFH WKH WHPSHUDWXUH VHQVLWLYLW\ RI WKH 30)6, ,W LV SURYHG E\ WKHRU\ DQG VLPXODWLRQ WKDW WKH WHPSHUDWXUH VHQVLQJ VHQVLWLYLW\ RI WKH 30)6, LV LQYHUVHO\ SURSRUWLRQDO WR

i WLPHV WKDW RI WKH IXQGDPHQWDO 9HUQLHU HIIHFW 7KHRUHWLFDOO\ WKH RUGHU RI KDUPRQLFV FDQ EH LQILQLWHO\ LQFUHDVHG DQG WKH VHQVLWLYLW\ RI WKH FRUUHVSRQGLQJVHQVRUEHFRPHVLQILQLWHO\LQFUHDVHG %XW H[SHULPHQWDOO\ DV WKH PRGXODWLRQ FRQWUDVW RI WKHXSSHUHQYHORSHGFUHDVHVZLWKDQLQFUHDVHLQWKH KDUPRQLF RUGHU WKHYLVLELOLW\ RI PRGXODWLRQ ZLOO EH GHWHULRUDWHG GXH WR VLJQDO QRLVH 6R WKH RUGHU RI KDUPRQLFV FDQ¶W EH LQILQLWHO\ LQFUHDVHG LQ WKH H[SHULPHQW ,Q DGGLWLRQ OLPLWHG E\ WKH ZDYHOHQJWK UDQJHRI%%6DQGWKHPRQLWRUDQJHRI26$XVHG LQWKHH[SHULPHQWWKHEHVWWHPSHUDWXUHUDQJH RI WKH VHQVRU ZLOO GHFUHDVH LQ WKH VHQVRU VHQVLWLYLW\ &RQVLGHULQJ WKH VHQVLWLYLW\ DQG PHDVXUDEOH WHPSHUDWXUH UDQJH RI WKH VHQVRU ZH ILQDOO\SURSRVHD30)6,WHPSHUDWXUHVHQVRUZLWKD GHWXQLQJ RI FP EDVHG RQ WKH VHFRQGRUGHU 9HUQLHU HIIHFW ZKLFK FDQ DFKLHYH WKH RSWLPXP VHQVLWLYLW\ LQ WKH WHPSHUDWXUH UDQJH RI RXU H[SHULPHQW

7KH H[SHULPHQWDO UHVXOWV VKRZ WKDW WKH WHPSHUDWXUH VHQVLWLYLW\ RI WKH 30)6, EDVHG RQ WKH VHFRQGRUGHU9HUQLHUHIIHFWFDQUHDFK± ZKLFKLV WLPHVWKDWRI WKH30)6,EDVHGRQWKH IXQGDPHQWDO 9HUQLHU HIIHFW 7KH SURSRVHG 30)6, EDVHG RQ WKH KDUPRQLF 9HUQLHU HIIHFW KDV WKH DGYDQWDJHV RI VLPSOH VWUXFWXUH ORZ FRVW DQG KLJK VHQVLQJ VHQVLWLYLW\ ZKLFK LV HVSHFLDOO\ VHQVLWLYH WR ZHDN WHPSHUDWXUH FKDQJHV DQG ,URD DSSOLFDWLRQ SURVSHFWVIRUDFFXUDWHWHPSHUDWXUHVHQVLQJ

$FNQRZOHGJPHQW

:HDFNQRZOHGJHWKHVXSSRUWVIURPWKH1DWLRQDO 1DWXUDO 6FLHQFH )RXQGDWLRQ RI &KLQD *UDQW 1R DQG 7DOHQW 3ODQ RI 1DQMLQJ

8QGHUZDWHU\RI3RVWVDQG7HOHFRPPXQLFDWLRQV

2SHQ$FFHVVZKLVDUWLFOHLVGLVWULEXWHGXQGHUWKHW
RI WKH &UHDWLYH &RPPRQV $WWULEXWLRQ ,QWHUQDWLF
KWWSFUHDWLYHFRPPRQVRUJOLFHQVHVE\
XQUHVWULFWHG XVH GLVWULEXWLRQ LQ DQ\ PHGLXP SURYLGHG \RX JLYH
SSSURSULDWHFUHGLWWRWKHRULJLQDODXWKRUVDQGWK
SURYLGH D OLQN WR WKH &UHDWLYH &RPPRQV OLFHQVH
LQGLFDWHLIFKDQJHVZHUHPDGH

5HIHUHQFHV

>@ Optics Letters±

>@ IEEE Photonics Technology Letters±

>@ Measurement±

>@ et al ³0DQHWLF ILHOG VHQVRU EDVHG RQ D FRPELQDWLRQ RI D PLFURILEHU FRXSOHU FRYHUHG ZL P D J Q H W L F I O X L G Sensing D 6 Reports

>@ Sensors and Actuators B Chemical±

>@ Optics Letters±

>@ Optical Fiber Technology ±

>@ Optical Engineering

>@ Optics Express±

>@ et al. ³+LJK\ VHQVLWLYH RSWLFDO WHPSHUDWXUH VHQVRU EDVHG RQ D 6L1 PLFURUL UHVRQDWRU ZLWK OLTXLG FU\VWDOOLQH GGLQ´

*Express*±

>@

*IEEE*

*Sensors Journal*±

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*Photonics*

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*Journal of Lightwave Technology*

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*et al*³6LJQDOSURFHVVLQJDVVLVWHG9HUQLHU HIIHFW LQ D VLQJOH LQWHUIHURPHWHU IRU VHQVLQJ PDJQLILFDWLRQ*Optics Express*

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>@

*et al.* ³6HQVLWLYLW\HQKDQFHG WHPSHUDWXUH VHQVRU ZLWK FDVFDGHG ILEHU RSWLF 6DJQDF *et al.*³7HPSHUDWXUHVHQVRUEDVHGRQILEHUULQJ *Communications*±

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*Optics Express*±

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*Optics and Precision Engineering*

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*et al.* ³2SWLFDO KDUPRQLF YHUQLHU HIIHFW D QHZ WRRO IRU KLJK SHUIRUPDQF LQWHUIHURPHWULFILEUH*Sensors*´

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*et al.* ³3KRWRQ FRXSOLQJLQGXFHG VSHFWUXP HQYHORSH PRGXODWLRQ LQ WKH FRXSO *et al.* ³9HUQLHU HIIHFW WR KDUPRQLF 9HU *Nanophotonics*±

>@

*et al.* ³)LEHURSWLF PLFURVWUXFWXUH VHQVRUV D *Photonic Sensors*±

*et al.*³7HPSHUDWXUHVHQVRUEDVHGRQILEHUULQJ *Photonics Technology Letters*±

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*Photonic Sensors*±