



## 1. Introduction

elsarticle.cls is a thoroughly re-written document class for formatting L<sup>A</sup>T<sub>E</sub>X submissions to Elsevier journals. The class uses the environments and commands defined in L<sup>A</sup>T<sub>E</sub>X kernel without any change in the signature so that clashes with other contributed L<sup>A</sup>T<sub>E</sub>X packages such as hyperref.sty, preview-latex.sty, etc., will be minimal. elsarticle.cls is primarily built upon the default article.cls. The class depends on the following packages for its proper functionality:

1. pifont.sty for openstar in the title footnotes;
2. natbib.sty for citation processing;
3. geometry.sty for margin settings;
4. fleqn.clo for left aligned equations;
5. graphicx.sty for graphics inclusion;
6. txfonts.sty optional font package, if document is to be formatted with Times and compatible math fonts;
7. hyperref.sty optional packages if hyperlinking is required in the document.

All the above packages are part of any standard L<sup>A</sup>T<sub>E</sub>X installation. Therefore, the users need not be bothered about downloading any extra packages. Furthermore, users are free to make use of AMS math packages such as, amsmath.sty, amsthm.sty, amssymb.sty, amsfonts.sty, etc., if they want to. All these packages work in tandem with elsarticle.cls without any problems.

## 2. Major Differences

Following are the major differences between elsarticle.cls and its predecessor package, elsart.cls:

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- Cross-references
- Mathematical Symbols and Formulae
- Bibliography
- Final Print

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- elsarticle.cls is built upon article.cls while elsart.cls is not. elsart.cls redefines many of the commands in the L<sup>A</sup>T<sub>E</sub>X classes/kernel, which can possibly cause surprising clashes with other contributed L<sup>A</sup>T<sub>E</sub>X packages;
- provides preprint document formatting by default, and optionally formats the document as per the final style of models 1+, 3+ and 5+ of Elsevier journals;
- some easier ways for formatting `list` and `theorem` environments are provided while people can still use amsthm.sty package;
- natbib.sty is the main citation processing package which can comprehensively handle all kinds of citations and works perfectly with hyperref.sty in combination with hypernat.sty.
- Long title pages are processed correctly in preprint and final formats.

## 3. Installation

The package is available at author resources page at Elsevier (<http://www.elsevier.com/locate/latex>). It can also be found in any of the nodes of the Comprehensive T<sub>E</sub>X Archive Network (CTAN), one of the primary nodes being <http://tug.ctan.org/tex-archive/macros/latex/contrib/elsarticle/> Please download the elsarticle.dtx which is the composite class with documentation and elsarticle.ins which is the L<sup>A</sup>T<sub>E</sub>X installer file. When we compile the elsarticle.ins with L<sup>A</sup>T<sub>E</sub>X it provides the class file, elsarticle.cls by stripping off all the documentation from the \*.dtx file. The class may be moved or copied to a place, usually, \$TEXMF/tex/latex/elsevier/, or a folder which will be read by L<sup>A</sup>T<sub>E</sub>X during document compilation. The T<sub>E</sub>X file database needs updation after moving/copying class file. Usually, we use commands like `mktexlsr` or `texhash` depending upon the distribution and operating system.

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## 4. Usage

The class should be loaded with the command:

```
\documentclass[<options>]{elsarticle}
```

where the **options** can be the following:

- (1) **preprint** — default options which formats the document for submission to Elsevier journals.
- (2) **review** — similar to **preprint** option, but increases the baselineskip to facilitate easier review process.
- (3) **1p** — formats the article to the look and feel of the final format of model 1+ journals. This is always single column style.
- (4) **3p** — formats the article to the look and feel of the final format of model 3+ journals. If the journal is a two column model, use **twocolumn** option in combination.
- (5) **5p** — formats for model 5+ journals. This is always two column style.
- (6) **authoryear** — author-year citation style of natbib.sty. If you want to add extra options of natbib.sty, you may use the options as a comma delimited strings as argument to **\biboptions** command. An example would be:

```
\biboptions{longnamesfirst,angle,semicolon}
```

- (7) **number** — numbered citation style. Extra options can be loaded with **\biboptions** command.
- (8) **sort&compress** sorts and compresses the numbered citations. For example, citation [1,2,3] will become [1–3].

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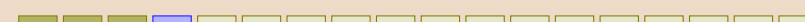




- (9) **longtitle** — if front matter is unusually long, use this option to split the title page across pages with the correct placement of title and author footnotes in the first page.
- (10) **times** — loads txfonts.sty if available in the system to use Times and com-

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```
\author[rvt]{C.V. ~Radhakrishnan\corref{cor1}\fnref{fn1}}  
\ead{cvr@river-valley.com}
```

```
\author[rvt,focal]{K. ~Bazargan\fnref{fn2}}  
\ead{kaveh@river-valley.com}
```

```
\author[els]{S. ~Pepping\corref{cor2}\fnref{fn1,fn3}}  
\ead[url]{http://www.elsevier.com}
```

```
\cortext[cor1]{Corresponding author}  
\cortext[cor2]{Principal corresponding author}  
\fntext[fn1]{This is the specimen author footnote.}  
\fntext[fn2]{Another author footnote, but a little more longer.}  
\fntext[fn3]{Yet another author footnote. Indeed, you can have  
any number of author footnotes.}
```

```
\address[rvt]{River Valley Technologies, SJP Building,  
Cotton Hills, Trivandrum, Kerala, India 695014}  
\address[focal]{River Valley Technologies, 9, Browns Court,  
Kennford, Exeter, United Kingdom}  
\address[els]{Central Application Management,  
Elsevier, Radarweg 29, 1043 NX\\  
Amsterdam, Netherlands}
```

You can see the output in the panel to the right.

Most of the commands like `\title`, `\author`, `\address` are self explanatory. Various components are linked to each other by a label–reference mechanism;

This is a specimen title

C.V. Radhakrishnan<sup>a,\*,1</sup>, K. Bazargan<sup>a,b,2</sup>, S. Pepping<sup>c,\*,1,3</sup>

<sup>a</sup>River Valley Technologies, SJP Building, Cotton Hills, Trivandrum, Kerala, India 695014

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## Abstract

In this work we demonstrate the formation of a new type of polariton on the interface between a cuprous oxide slab and a polystyrene micro-sphere placed on the slab. The evanescent field of the resonant whispering gallery mode (WGM) of the micro sphere has a substantial gradient, and therefore effectively couples with the quadrupole 1S excitons in cuprous oxide. This evanescent polariton has a long life-time, which is determined only by its excitonic and WGM component. The polariton lower branch has a well pronounced minimum. This suggests that this excitation is localized and can be utilized for possible BEC. The spatial coherence of the polariton can be improved by assembling the micro-spheres into a linear chain.

*Key words:* quadrupole exciton, polariton, WGM, BEC

## 1. Introduction

Although quadrupole excitons (QE) in cuprous oxide crystals are good candidates for BEC due to their narrow line-width and long life-time there are some factors impeding BEC [Kavoulakis and Baym \(1996\)](#); [Roslyak and Birman \(2007\)](#). One of these factors is that due to the small but non negligible coupling

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The second title footnote which is a longer longer than the first one and with an intention to fill in up more than one line while formatting.

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<sup>1</sup>This is the specimen author footnote.

<sup>2</sup>Another author footnote, but a little more longer.

<sup>3</sup>Yet another author footnote. Indeed, you can have any number of author footnotes.



for instance, title footnote is linked to the title with a footnote mark generated by referring to the `\label` string of the `\tnotetext`. We have used similar commands such as `\tnoteref` (to link title note to title); `\corref` (to link corresponding author text to corresponding author); `\fnref` (to link footnote text to the relevant author names).  $\text{\TeX}$  needs two compilations to resolve the footnote marks in the frontmatter part. Given below are the syntax of various note marks and note texts.

```
\tnoteref{<label(s)>}
\corref{<label(s)>}
\fnref{<label(s)>}
\tnotetext[<label>]{<title note text>}
\cortext[<label>]{<corresponding author note text>}
\fnref{<label>}{<author footnote text>}
```

where `<label(s)>` can be either one or more comma delimited label strings. The optional arguments to the `\author` command holds the ref label(s) of the address(es) to which the author is affiliated while each `\address` command can have an optional argument of a label. In the same manner, `\tnotetext`, `\fnref`, `\cortext` will have optional arguments as their respective labels and note text as their mandatory argument.

The following example code provides the markup of the second type of author-affiliation as seen in the output given in the box to the right.

```
\author{C.V.~Radhakrishnan\corref{cor1}\fnref{fn1}}
\ead{cvr@river-valley.com}
\address{River Valley Technologies, SJP Building,
Cotton Hills, Trivandrum, Kerala, India 695014}
```

This is a specimen title

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*River Valley Technologies, SJP Building, Cotton Hills, Trivandrum, Kerala, India 695014*

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## Abstract

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*Key words:* quadrupole exciton, polariton, WGM, BEC

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The second title footnote which is a longer longer than the first one and with an intention to fill in up more than one line while formatting.

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Email addresses: cvr@river-valley.com (C.V. Radhakrishnan),  
kaveh@river-valley.com (K. Bazargan)

URL: <http://www.elsevier.com> (S. Pepping)

<sup>1</sup>This is the first author footnote.

<sup>2</sup>Another author footnote, this is a very long footnote and it should be a really long footnote. But this footnote is not yet sufficiently long enough to make two lines of footnote text.

<sup>3</sup>Yet another author footnote.



```
\author{K.~Bazargan\fnref{fn2}}  
\ead{kaveh@river-valley.com}  
\address{River Valley Technologies, 9, Browns Court, Kennford,  
Exeter, UK.}
```

```
\author{S.~Pepping\fnref{fn1,fn3}}  
\ead[url]{http://www.elsevier.com}  
\address{Central Application Management,  
Elsevier, Radarweg 43, 1043 NX Amsterdam, Netherlands}
```

```
\cortext[cor1]{Corresponding author}  
\fntext[fn1]{This is the first author footnote.}  
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it should be a really long footnote. But this footnote is not yet  
sufficiently long enough to make two lines of footnote text.}  
\fntext[fn3]{Yet another author footnote.}
```

The frontmatter part has further environments such as abstract and key-words. These can be marked up in the following manner:

```
\begin{abstract}  
In this work we demonstrate the formation of a new type of  
polariton on the interface between a ....  
\end{abstract}
```

```
\begin{keyword}  
quadruple exciton \sep polariton \sep WGM\sep BEC  
\end{keywordd}
```

This is a specimen title

C.V. Radhakrishnan<sup>\*1</sup>

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*Email addresses:* cvr@river-valley.com (C.V. Radhakrishnan),  
kaveh@river-valley.com (K. Bazargan)

*URL:* http://www.elsevier.com (S. Pepping)

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<sup>3</sup>Yet another author footnote.



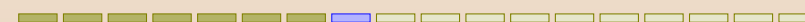


## 6. Floats

The **table** environment is any sort of table.

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```
\begin{enumerate}[a]  
\item Another level of list with alphabetical counter.  
\item One more item before we start another.
```

```
\begin{enumerate}[(i)]  
\item This item has roman numeral counter.  
\item Another one before we close the third level.  
\end{enumerate}  
\item Third item in second level.  
\end{enumerate}  
\item All list items conclude with this step.  
\end{enumerate}
```

Roll over [your mouse here](#) to see the typeset copy of the above code. Furthermore, the enhanced list environment allows one to prefix a string like 'step' to all the item numbers. Take a look at the example below:

```
\begin{enumerate}[Step 1.]  
\item This is the first step of the example list.  
\item Obviously this is the second step.  
\item The final step to wind up this example.  
\end{enumerate}
```

[Here is the typeset output](#) of the above example code.

## 9. Cross-references

In electronic publications, articles may be internally hyperlinked. Hyperlinks are generated from proper cross-references in the article. For example, the

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words Fig. 1 will never be more than simple text, whereas the proper cross-reference `\ref{tiger}` may be turned into a hyperlink to the figure itself: Fig. 1. In the same way, the words Ref. [1] will fail to turn into a hyperlink; the proper cross-reference is `\cite{Knuth96}`. Cross-referencing is possible in L<sup>A</sup>T<sub>E</sub>X for sections, subsections, formulae, figures, tables, and literature references.

## 10. Mathematical symbols and formulae

Many physical/mathematical sciences authors require more mathematical symbols than the few that are provided in standard L<sup>A</sup>T<sub>E</sub>X. A useful package for additional symbols is the `amssymb` package, developed by the American Mathematical Society. This package includes such oft-used symbols as `\lessim` for  $\lesssim$ , `\gtrsim` for  $\gtrsim$  or `\hbar` for  $\hbar$ . Note that your T<sub>E</sub>X system should have the `msam` and `msbm` fonts installed. If you need only a few symbols, such as `\Box` for  $\square$ , you might try the package `latexsym`.

Another point which would require authors' attention is the breaking of longer equations. When you use `elsarticle.cls` for formatting your submissions in `preprint` mode, the document is formatted in single column style with a text width of 384pt or 5.3in. When this document is formatted for final print and if the journal happens to be a double column journal, the text width will be reduced to 224pt at for 3+ double column and 5+ journals respectively. All the nifty fine-tuning in equation breaking done by the author goes to waste in such cases. Therefore, authors are requested to check this problem by typesetting their submissions in final format as well just to see if their equations are broken at appropriate places, by changing appropriate options in the document class loading command, which is explained in section 4, Usage. This allows authors to fix any equation breaking problem before submission for publication. `elsarticle.cls` supports formatting the author submission in different types of final format. This is further discussed in section 12, Final print.

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## 11. Bibliography

Three bibliographic style files (`*.bst`) are provided — `elsarticle-num.bst`, `elsarticle-num-names.bst` and `elsarticle-harv.bst` — the first one for the numbered scheme, the second for the numbered with new options of `natbib.sty` and the last one for the author year scheme.

In  $\text{\LaTeX}$  literature references are listed in the `thebibliography` environment. Each reference is a `\bibitem` and each `\bibitem` is identified by a label, by which it can be cited in the text:

`\bibitem[Elson et al.(1996)]{ESG96}` is cited as `\citet{ESG96}`.

In connection with cross-referencing and possible future hyperlinking it is not a good idea to collect more than one literature item in one `\bibitem`. The so-called Harvard or author-year style of referencing is enabled by the  $\text{\LaTeX}$  package `natbib`. With this package the literature can be cited as follows:

- Parenthetical: `\citep{WB96}` produces (Wettig & Brown, 1996).
- Textual: `\citet{ESG96}` produces Elson et al. (1996).
- An affix and part of a reference: `\citep[e.g.][Ch. 2]{Gea97}` produces (e.g. Governato et al., 1997, Ch. 2).

In the numbered scheme of citation, `\cite{<label>}` is used, since `\citep` or `\citet` has no relevance in numbered scheme. `natbib` package is loaded by `elsarticle` with `numbers` as default option. You can change this to author-year or harvard scheme by adding option `authoryear` in the class loading command. If you want to use more options of the `natbib` package, you can do so with the `\biboptions` command, which is described in section 4, [Usage](#). For details of various options of the `natbib` package, please take a look at the `natbib` documentation, which is part of any standard  $\text{\LaTeX}$  installation.

In addition to the above standard `.bst` files, there are 10 journal-specific `.bst` files also available. Instruction for using these `.bst` files can be found at <http://support.river-valley.com>

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Clip 2: See equation (6) overprints into second column.

Fuller (1991); Miyazaki and Jimba (2000) and are explicitly listed in the Appendix.

The bulk (incident) and evanescent polaritons in cuprous oxide are formed through the quadrupole part of the light-matter interaction:

$$\mathbf{M}_{1,39} = A_{1,39}^{ml} (r_0 + \delta r) \mathbf{M}_{ml} + B_{1,39}^{ml} (r_0 + \delta r) \mathbf{N}_{ml} \quad (5)$$

Here  $e$ ,  $m$  are the electron charge and mass;  $\mathbf{p}$  is the electron momentum. For the quadrupole  $1S$  transition in cuprous oxide the energy of interaction can be written as:

$$\sum_{n=0}^{\infty} A^n \int dx \frac{F_n(x)}{A_n + B_n} = B^n C^n \int dx \int dy \frac{G_n(x, y)}{A_n x + B_n y} + \frac{G_n(x, y)}{A_n x + B_n y} \quad (6)$$

Here we introduced the initial state of the system, which

penetrating into cuprous oxide, although the coupling grows with mode number  $l$ , because the gradient of the evanescent field increases. Note that QE realizes *strong* coupling regime  $g_{1,39} > \gamma$  while DE demonstrates *weak* regime only Xudong Fan (1999). The property of the scalable coupling factor can be utilized in practical applications such as non-linear optics and is the subject of our future work.

### 3. Results and discussion

In this section let us utilize the above calculated WGM-QE interaction to obtain the evanescent polariton (EP) dispersion in the framework of the coupled oscillator model that has been widely used for describing coupled atom-photon or exciton-photon modes in micro-

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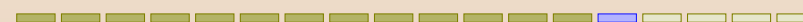
The typesetter will try to break the equation which need not necessarily be to the liking of the author or as it happens, typesetter's break point may be semantically incorrect. Therefore, authors may check their submissions for the incidence of such long equations and break the equations at the correct places so that the final typeset copy will be as they wish.

## 12. Final print

Authors can format their submission to the page size and margins of their preferred journal. elsarticle provides four class options for the same:

1p: 1+ journals with a text area of 384pt  $\times$  562pt or 13.5cm  $\times$  19.75cm or 5.3in  $\times$  7.78in, single column style only.

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3p: 3+ journals with a text area of 468pt × 622pt or 16.45cm × 21.9cm or 6.5in × 8.6in, single column style.

3pd: 3+ with the same text area as above, double column style.

5p: 5+ with text area of 522pt × 682pt or 18.35cm × 24cm or 7.22in × 9.45in, double column style only.

Following pages have the clippings of different parts of the first page of different journal models typeset in final format.

Clip 3: Upper part of first page of a single column article.

This is a specimen title

C.V. Radhakrishnan<sup>a,\*,1</sup>, K. Bazargan<sup>a,b,2</sup>, S. Pepping<sup>c,\*\*,1,3</sup>

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Amsterdam, Netherlands*

## Abstract

In this work we demonstrate the formation of a new type of polariton on the interface between a cuprous oxide slab and a polystyrene micro-sphere placed on the slab. The evanescent field of the resonant whispering gallery mode (WGM) of the micro sphere has a substantial gradient, and therefore effectively couples with the quadrupole 1S excitons in cuprous oxide. This evanescent polariton has a long life-time, which is determined only by its excitonic and WGM component. The polariton lower branch has a well pronounced minimum. This suggests that this excitation is localized and can be utilized for possible BEC. The spatial coherence of the polariton can be improved by assembling the micro-spheres into a linear chain.

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Clip 4: Lower part of first page of a single column article.

Key words: quadrupole exciton, polariton, WGM, BEC

## 1. Introduction

Although quadrupole excitons (QE) in cuprous oxide crystals are good candidates for BEC due to their narrow line-width and long life-time there are some factors impeding BEC [Kavoulakis and Baym \(1996\)](#); [Roslyak and Birman \(2007\)](#). One of these factors is that due to the small but non negligible coupling to the photon bath, one must consider BEC of the corresponding mixed light-matter states called polaritons [Frohlich et al. \(2005\)](#). The photon-like part of the polariton has a large group velocity and tends to escape from the crystal. Thus, the temporal coherence of the condensate is effectively broken [Eli et al. \(1998\)](#); [Snoke \(2002\)](#). One proposed solution to

This document is a collaborative effort.

The second title footnote which is a longer longer than the first one and with an intention to fill in up more than one line while formatting.

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URL: <http://www.elsevier.com> (S. Pepping)

<sup>1</sup>This is the specimen author footnote.

<sup>2</sup>Another author footnote, but a little more longer.

<sup>3</sup>Yet another author footnote. Indeed, you can have any number of author footnotes.

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February 14, 2008

Model 1+ and 3+ will have the same look and feel in the typeset copy when presented in this document. That is also the case with the double column 3+ and 5+ journal article pages. The only difference will be wider text width of higher models. Therefore we will look at the different portions of a typical single column journal page and that of a double column article in the final format.

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Clip 5: Upper part of first page of a typical double column article.

This is a specimen title

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**Key words:** quadrupole exciton, polariton, WGM, BEC

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proposed solution to this issue is to place the crystal into a planar micro-cavity Kasprzak et al. (2006). But even state-of-the-art planar micro-cavities can hold the light no longer than  $10 \mu s$ . Besides, formation of the polaritons in the planar cuprous oxide micro-cavity is not effective due to quadrupole origin of the excitons.

Therefore in this work we propose to prevent the polariton escaping by trapping it into a whispering gallery

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Clip 6: Lower part of first page a typical double column article.

## Abstract

In this work we demonstrate the formation of a new type of polariton on the interface between a cuprous oxide slab and a polystyrene micro-sphere placed on the slab. The evanescent field of the resonant whispering gallery mode (WGM) of the micro sphere has a substantial gradient, and therefore effectively couples with the quadrupole 1S excitons in cuprous oxide. This evanescent polariton has a long life-time, which is determined only by its excitonic and WGM component. The polariton lower branch has a well pronounced minimum. This suggests that this excitation is localized and can be utilized for possible BEC. The spatial coherence of the polariton can be improved by assembling the micro-spheres into a linear chain.

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proposed solution to this issue is to place the crystal into a planar micro-cavity [Kasprzak et al. \(2006\)](#). But even state-of-the-art planar micro-cavities can hold the light no longer than  $10 \mu s$ . Besides, formation of the polaritons in the planar cuprous oxide micro-cavity is not effective due to quadrupole origin of the excitons.

Therefore in this work we propose to prevent the polariton escaping by trapping it into a whispering gallery mode (WGM)<sup>4</sup> of a polystyrene micro-sphere (PMS).

We develop a model which demonstrates formation of a strongly *localized* polariton-like quasi-particle. This quasi-particle is formed by the *resonant* interaction between the WGM in PMS and QE in the adjacent layer of cuprous oxide. The QE interacts with the *gradient* of the WGM evanescent field.

There are few experiments concerned with resonant interaction of the WGM and dipole allowed exciton (DE) [Xudong Fan \(1999\)](#); [Fan et al. \(1999\)](#). But the DE has some disadvantages compared to QE when it comes to interaction with the WGM. First, the evanescent light has small intensity. Therefore it is not effective for the

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