

| <b>REPORT DOCUMENTATION PAGE</b>  |                         |                                | <i>Form Approved</i><br><i>OMB No. 0704-0188</i>                          |  |  |
|---|-------------------------|--------------------------------|---|--|--|
| Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing this collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden to Department of Defense, Washington Headquarters Services, Directorate for Information Operations and Reports (0704-0188), 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to any penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number. <b>PLEASE DO NOT RETURN YOUR FORM TO THE ABOVE ADDRESS.</b>   |                         |                                |   |  |  |
| <b>1. REPORT DATE (DD-MM-YYYY)</b><br>24-01-2011  |                         | <b>2. REPORT TYPE</b><br>Final |   | <b>3. DATES COVERED (From - To)</b><br>01-09-2009 - 31-12-2010 |  |
| <b>4. TITLE AND SUBTITLE</b><br>SURFACE PLASMON RESONANCES IN 1D- AND 2D- ARRAYS OF METAL NANOPARTICLES FOR THE CONTROL OF ENHANCED SPECTROSCOPIES  |                         |                                | <b>5a. CONTRACT NUMBER</b>  |  |  |
|   |                         |                                | <b>5b. GRANT NUMBER</b><br>FA9550-09-1-0579                               |  |  |
|   |                         |                                | <b>5c. PROGRAM ELEMENT NUMBER</b>   |  |  |
| <b>6. AUTHOR(S)</b><br>Noguez, Cecilia<br>Roman-Velazquez, Carlos E.<br>Angulo, Ali M.  |                         |                                | <b>5d. PROJECT NUMBER</b>   |  |  |
|   |                         |                                | <b>5e. TASK NUMBER</b>  |  |  |
|   |                         |                                | <b>5f. WORK UNIT NUMBER</b>   |  |  |
| <b>7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)</b><br>Instituto de Fisica<br>Universidad Nacional Autonoma de Mexico<br>Ciudad Universitaria, Del. Coyoacan, C.P. 04510, Mexico D.F.   |                         |                                | <b>8. PERFORMING ORGANIZATION REPORT NUMBER</b>                           |  |  |
| <b>9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)</b><br>AFOSR/JA (703) 696-9705<br>875 NORTH RANDOLPH STREET<br>SUITE 325, ROOM 3112 ARLINGTON, VA. 22203   |                         |                                | <b>10. SPONSOR/MONITOR'S ACRONYM(S)</b><br>USAF AFOSR                     |  |  |
|   |                         |                                | <b>11. SPONSOR/MONITOR'S REPORT NUMBER(S)</b><br>AFRL-OSR-VA-TR-2012-0731 |  |  |
| <b>12. DISTRIBUTION / AVAILABILITY STATEMENT</b><br>Public availability   |                         |                                |   |  |  |
| <b>13. SUPPLEMENTARY NOTES</b>  |                         |                                |   |  |  |
| <b>14. ABSTRACT</b><br>A spectral representation formalism was developed to determine the effects of the different parameters, shape, size, geometrical and material composition of the system, to clearly understand the properties of surface plasmons. With this knowledge it was possible determine how to modify the frequency, intensity, spatial localization and other characteristic ingredients of the surface plasmons in noble metal nanoparticles. The spectral representation formalism can be applied to understand the interaction among nanoparticles, and thus it can be applied to study surface plasmon resonances on 1D and 2D arrays for the control of enhanced spectroscopies. This work was published in the Journal of Chemical Physics (2011). We also developed analytical expressions to study metallic wedges and their role to maximize the electromagnetic field enhancements, which could be useful to analyze certain molecules using Surface Enhanced Raman Spectroscopy (SERS) and Plasmon-controlled or Metal Enhanced Fluorescence Spectroscopy (MEFS). This work will be submitted soon. |                         |                                |   |  |  |
| <b>15. SUBJECT TERMS</b><br>Surface plasmon resonances, noble metal nanoparticles, spectral representation, nanoshells, nanospheres   |                         |                                |   |  |  |
| <b>16. SECURITY CLASSIFICATION OF:</b>  |                         |                                | <b>17. LIMITATION OF ABSTRACT</b><br>SAR                                  | <b>18. NUMBER OF PAGES</b><br>2                                | <b>19a. NAME OF RESPONSIBLE PERSON</b><br>Cecilia Noguez               |
| <b>a. REPORT</b><br>U   | <b>b. ABSTRACT</b><br>U | <b>c. THIS PAGE</b><br>U       |   |  | <b>19b. TELEPHONE NUMBER (include area code)</b><br>+52 (55) 5622 5106 |

Final Technical Report

Grant/Contract Title: SURFACE PLASMON RESONANCES IN 1D- AND 2D-ARRAYS OF METAL NANOPARTICLES FOR THE CONTROL OF ENHANCED SPECTROSCOPIES

Grant/Contract Number: FA9550-09-1-0579

Carlos E. Román-Velázquez and Cecilia Noguez

*Instituto de Física, Universidad Nacional Autónoma de México*

**Reporting Period:** 10/09 to 12/10

**Annual accomplishments** (200 words max): A spectral representation formalism was developed to determine the effects of the different parameters, shape, size, geometrical and material composition of the system, to clearly understand the properties of surface plasmons. With this knowledge it was possible determine how to modify the frequency, intensity, spatial localization and other characteristic ingredients of the surface plasmons in noble metal nanoparticles. The spectral representation formalism can be applied to understand the interaction among nanoparticles, and thus it can be applied to study surface plasmon resonances on 1D and 2D arrays for the control of enhanced spectroscopies. This work was published in the Journal of Chemical Physics (2011). We also developed analytical expressions to study metallic wedges and their role to maximize the electromagnetic field enhancements, which could be useful to analyze certain molecules using Surface Enhanced Raman Spectroscopy (SERS) and Plasmon-controlled or Metal Enhanced Fluorescence Spectroscopy (MEFS). This work will be submitted soon.

**Archival publications** (published) during reporting period:

1. C. E. Román-Velázquez, Cecilia Noguez, “*Designing the plasmonic response of shell nanoparticles: Spectral representation*” The Journal of Chemical Physics **134**, 044116 (2011).

**Changes in research objectives**, if any: None

**Change in AFOSR program manager**, if any: None

**Extensions granted or milestones slipped**, if any: None

**Include any new discoveries**, inventions, or patent disclosures during this reporting period (if none, report none): none