

## Technical Specification for EQE and IQE measurement system

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| Type of Measurements                           | <ul style="list-style-type: none"> <li>• System should be able to measure External quantum efficiency (EQE) and Internal quantum efficiency (IQE)</li> <li>• Light tight enclosure for sample</li> </ul>  |
| Light Source                                   | <ul style="list-style-type: none"> <li>• Xe lamp (75 W or higher)</li> <li>• High stability (Deviation should be less than 1% in 48 hours)</li> <li>• If required, it should be equipped with three axis adjustable knob</li> <li>• Power supply</li> <li>• Lamp time keeper</li> </ul>   |
| Monochromator                                  | <ul style="list-style-type: none"> <li>• Resolution <math>\leq 1</math> nm</li> <li>• Spectral region 300 – 1800 nm (continuous light)</li> <li>• Scanning interval: variable between 0.1 nm – 50 nm</li> <li>• F# should be <math>\leq f/4</math></li> <li>• Focal length can be 100 mm – 250 mm</li> <li>• Stray light <math>\leq 0.05</math> %</li> <li>• Should be compatible with all other items like light source, filter wheel etc.</li> </ul>  |
| Optical System                                 | <ul style="list-style-type: none"> <li>• Spot size area should be at least 1 sq mm</li> <li>• If rectangular spot, the minimum size should be 0.5 mm</li> <li>• Indicate the output light intensity</li> </ul>  |
| Optical Chopper                                | <ul style="list-style-type: none"> <li>• Frequency 4 Hz – 100 Hz or higher</li> <li>• Computer controlled</li> <li>• Stable time to change the frequency &lt; 3 seconds</li> <li>• Resolution should be 0.01 Hz</li> <li>• -180 degree to +179 degree phase shifter with 0.1 degree resolution</li> </ul>   |
| Filter wheel                                   | <ul style="list-style-type: none"> <li>• Automatic 4 or more position filter wheels with filters</li> <li>• Display of filter wheel position</li> </ul>   |
| Lock-in-Amplifier                              | <ul style="list-style-type: none"> <li>• One/Two DSP lock-in amplifiers</li> <li>• Maximum acquisition speed &lt; 25 us (signal)</li> <li>• Two DSP simultaneous working mode speed &lt; 50us,</li> <li>• Time delay between two amplifier &lt;1 us</li> <li>• Time constant: 0.001~100 sec, user setting</li> <li>• Roll-off filter</li> <li>• RXY<math>\theta</math> measurement function</li> <li>• Maximum gain: <math>10^7</math></li> <li>• Maximum sensitivity: 1nA</li> <li>• Maximum input voltage: 10V</li> </ul> |
| Current amplifier                              | <ul style="list-style-type: none"> <li>• Mention the specifications of the current amplifier</li> </ul>   |
| Internal Quantum Efficiency Measurement Module | <ul style="list-style-type: none"> <li>• 2" integrating sphere</li> <li>• Integrating sphere aperture: 1.4 cm or more</li> <li>• Incident angle: 8° (if others, please specify)</li> <li>• EQE and IQE can be measured at the same point</li> <li>• IQE measurement beam size: 1 mm</li> <li>• Reflectance and internal quantum efficiency measurement calculation procedure</li> <li>• IQE and Reflectivity measurement wavelength: 300-1100nm</li> </ul>  |

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|                           | <ul style="list-style-type: none"> <li>• Standard reflectivity white board with traceable report.</li> <li>• Average repeatability <math>\geq \pm 99\%</math></li> </ul>  |
| Oscillograph (Optional)   | <ul style="list-style-type: none"> <li>• Oscillography display window</li> <li>• Time domain signal and frequency domain signal analysis and displaying</li> <li>• Maximum time domain: 10 s</li> <li>• Signal monitoring function: should monitor the photo current variation of test sample</li> <li>• 4 to 1 automatic multi-channel switcher</li> <li>• Two independent channels for EQE, IQE</li> <li>• Analog input resolution: 14 Bits (ADC: Analog Digital Converter)</li> <li>• Maximum resolution of sample rating: 48 KS/s</li> <li>• Maximum voltage: <math>\pm 10V</math>, accuracy 7.73 mV</li> <li>• Minimum read current: 1 nA</li> </ul>   |
| DC Mode (Optional)        | <ul style="list-style-type: none"> <li>• DC mode switching mechanism, without any need of re-alignment.</li> <li>• Current measuring circuit and software should be included</li> </ul>   |
| Other specifications      | <ul style="list-style-type: none"> <li>• Specify the working distance</li> <li>• Spectral response uncertainty <math>&lt; \pm 0.5\%</math> of measured value</li> <li>• Spectral response repeatability <math>&lt; \pm 3\%</math> of measured value. 350-1100 nm</li> <li>• EQE uncertainty <math>&lt; \pm 3\%</math> of measured value. 350-1100 nm</li> <li>• IQE uncertainty <math>&lt; \pm 4.5\%</math> of measured value. 350-1100 nm</li> <li>• Specular reflectance uncertainty <math>&lt; \pm 2.1\%</math> of measured value up to 20% reflective surfaces, 350-1100 nm</li> <li>• Specular reflectance repeatability <math>&lt; \pm 1\%</math> of measured value. 350-1100 nm</li> <li>• Spectral Bandwidth : 1-40 nm</li> </ul> |
| System control & software | <ul style="list-style-type: none"> <li>• Software controlled data acquisition</li> <li>• Direct reports of measurement results including SR, IPCE, EQE, IQE</li> </ul>  |
| Utilities                 | <ul style="list-style-type: none"> <li>• Power supply: Voltage 220 V, 50Hz,</li> </ul>  |
| Reference Detector        | <ul style="list-style-type: none"> <li>• Detector range 300 – 1100 nm</li> <li>• Active area should be 1 x 1 cm<sup>2</sup> and non-uniformity should be <math>&lt; 5\%</math></li> <li>• With NIST traceable report and certified by calibration lab</li> </ul>  |
| Optional                  | <ul style="list-style-type: none"> <li>• Light Bias</li> </ul>  |
| General                   | <ul style="list-style-type: none"> <li>• The system should have safety compliance should be according to ISO</li> <li>• All pre installation requirements (table size, power supply etc.) should be clearly mentioned in the quotation</li> <li>• Soft and hard copy of the manual should be provided with the instrument</li> <li>• Test report of the instrument should be provided</li> <li>• Free installation training session to be done</li> <li>• System should have at least one year warranty from the date of installation</li> </ul>  |