XUV Multilayer Mirrors

NTT Advanced Technology Corporation
NTT Advanced Technology have been developing and supplying multilayer mirrors (MLMs) for extreme ultraviolet (XUV) region from mid 1990’s. Since, the products were used in a lot of fields such as astronomy, XUV photoelectron spectroscopy, XUV microscopy, EUV lithography, plasma physics, and attosecond science.

For high-quality MLM fabrications, no only fabrication techniques but also optical design know-how is necessary. We have been supplying a lot of kinds of MLMs for XUV region, corresponding to the customers' requirements, such as high reflectivity, broad bandwidth, narrow bandwidth, and high contrast. High thermal tolerance MLMs and high damage threshold MLMs have also been supplied.

Our fabrication techniques and optical design know-how will support your research and developments. Please kindly find the detail information of our XUV MLMs for suitable for your experiments. Please kindly contact us, custom design MLMs will be also designed for you.
High reflectivity XUV MLMs are useful for several application as a steering device and a focusing device. They are also used for X-ray telescope and X-ray microscopy.

<table>
<thead>
<tr>
<th>No</th>
<th>design name</th>
<th>AOI</th>
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<th>reflectivity</th>
<th>bandwidth (FWHM)</th>
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<td>s</td>
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<tr>
<td>peak energy</td>
<td>98 eV    (12.7 nm)</td>
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<tr>
<td>peak reflectivity</td>
<td>67.7%</td>
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<td>bandwidth (FWHM)</td>
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**HR-95-3.8**

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<td>peak energy</td>
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<td>peak reflectivity</td>
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**Design name** | **HR-90-3.8**
---|---
AOI | 5 deg
polarization | s
peak energy | 90 eV (13.8 nm)
peak reflectivity | 68.0%
bandwidth (FWHM) | 3.8 eV (0.6 nm)

**Design name** | **HR-85-4.0**
---|---
AOI | 5 deg
polarization | s
peak energy | 85 eV (14.6 nm)
peak reflectivity | 66.8%
bandwidth (FWHM) | 4.0 eV (0.7 nm)
Design name | HR-80-4.0
---|---
AOI | 5 deg
polarization | s
peak energy | 80 eV (15.5 nm)
peak reflectivity | 63.3%
bandwidth (FWHM) | 4.0 eV (0.8 nm)

Design name | HR-75-4.6
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AOI | 5 deg
polarization | s
peak energy | 75 eV (16.5 nm)
peak reflectivity | 54.5%
bandwidth (FWHM) | 4.6 eV (1.0 nm)
### Design name: HR-70-2.6

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<tr>
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<td>$s$</td>
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HR-35-2.6

Design name: HR-35-2.6

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HR-30-3.0

Design name: HR-30-3.0

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Design name | HR45-70-3.6  
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peak energy | 70 eV (17.7 nm)  
peak reflectivity | 49.0%  
bandwidth (FWHM) | 3.6 eV (0.9 nm)

**HR45-60-5.4**

Design name | HR45-60-5.4  
AOI | 45 deg  
 polarization | s  
peak energy | 60 eV (20.7 nm)  
peak reflectivity | 40.8%  
bandwidth (FWHM) | 5.4 eV (1.8 nm)
Design name | HR45-50-10.0
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AOI | 45 deg
polarization | s
peak energy | 50 eV (24.8 nm)
peak reflectivity | 30.0%
bandwidth (FWHM) | 10.0 eV (5.1 nm)

Design name | HR45-40-5.0
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AOI | 45 deg
polarization | s
peak energy | 40 eV (31 nm)
peak reflectivity | 44.4%
bandwidth (FWHM) | 5.0 eV (3.8 nm)
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<td>bandwidth (FWHM)</td>
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Narrowband XUV MLMs are used as spectroscopy devices, such as XUV spectroscopy, XUV photoelectron spectroscopy, and order isolation for high-order harmonics.

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<td>45 eV (27.6 nm)</td>
<td>47.6%</td>
<td>1.5 eV (0.9 nm)</td>
</tr>
<tr>
<td>37</td>
<td>NBR-40-1.5</td>
<td>5 deg</td>
<td>s</td>
<td>40 eV (31.0 nm)</td>
<td>44.8%</td>
<td>1.5 eV (1.1 nm)</td>
</tr>
<tr>
<td>38</td>
<td>NBR-35-1.6</td>
<td>5 deg</td>
<td>s</td>
<td>35 eV (35.4 nm)</td>
<td>43.7%</td>
<td>1.6 eV (1.6 nm)</td>
</tr>
<tr>
<td>39</td>
<td>NBR-30-1.9</td>
<td>5 deg</td>
<td>s</td>
<td>30 eV (41.3 nm)</td>
<td>42.0%</td>
<td>1.9 eV (2.6 nm)</td>
</tr>
<tr>
<td>40</td>
<td>NBR45-90-3.1</td>
<td>45 deg</td>
<td>s</td>
<td>90 eV (12.7 nm)</td>
<td>53.2%</td>
<td>3.1 eV (0.5 nm)</td>
</tr>
<tr>
<td>41</td>
<td>NBR45-70-2.6</td>
<td>45 deg</td>
<td>s</td>
<td>70 eV (17.7 nm)</td>
<td>45.6%</td>
<td>2.6 eV (0.7 nm)</td>
</tr>
<tr>
<td>42</td>
<td>NBR45-40-2.9</td>
<td>45 deg</td>
<td>s</td>
<td>40 eV (31.0 nm)</td>
<td>46.5%</td>
<td>2.9 eV (2.2 nm)</td>
</tr>
</tbody>
</table>
**Design name** | **NRB-98-2.3**  
---|---  
AOI | 5 deg  
polarization | s  
peak energy | 98 eV (12.7 nm)  
peak reflectivity | 39.5%  
bandwidth (FWHM) | 2.3 eV (0.3 nm)

**Design name** | **NNR-95-2.6**  
---|---  
AOI | 5 deg  
polarization | s  
peak energy | 95 eV (13.1 nm)  
peak reflectivity | 40.7%  
bandwidth (FWHM) | 2.6 eV (0.4 nm)
### NBR-90-2.5

<table>
<thead>
<tr>
<th>Design name</th>
<th>NBR-90-2.5</th>
</tr>
</thead>
<tbody>
<tr>
<td>AOI</td>
<td>5 deg</td>
</tr>
<tr>
<td>polarization</td>
<td>s</td>
</tr>
<tr>
<td>peak energy</td>
<td>90 eV (13.8 nm)</td>
</tr>
<tr>
<td>peak reflectivity</td>
<td>44.5%</td>
</tr>
<tr>
<td>bandwidth (FWHM)</td>
<td>2.5 eV (0.4 nm)</td>
</tr>
</tbody>
</table>

### NBR-85-2.5

<table>
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<th>NNR-85-2.5</th>
</tr>
</thead>
<tbody>
<tr>
<td>AOI</td>
<td>5 deg</td>
</tr>
<tr>
<td>polarization</td>
<td>s</td>
</tr>
<tr>
<td>peak energy</td>
<td>85 eV (14.6 nm)</td>
</tr>
<tr>
<td>peak reflectivity</td>
<td>48.5%</td>
</tr>
<tr>
<td>bandwidth (FWHM)</td>
<td>2.5 eV (0.4 nm)</td>
</tr>
</tbody>
</table>
**NBR-80-2.5**

<table>
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<th>NRB-80-2.5</th>
</tr>
</thead>
<tbody>
<tr>
<td>AOI</td>
<td>5 deg</td>
</tr>
<tr>
<td>polarization</td>
<td>s</td>
</tr>
<tr>
<td>peak energy</td>
<td>80 eV (15.5 nm)</td>
</tr>
<tr>
<td>peak reflectivity</td>
<td>50.1%</td>
</tr>
<tr>
<td>bandwidth (FWHM)</td>
<td>2.5 eV (0.5 nm)</td>
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</tbody>
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**NBR-75-2.6**

<table>
<thead>
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<th>NNR-75-2.6</th>
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</thead>
<tbody>
<tr>
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<td>5 deg</td>
</tr>
<tr>
<td>polarization</td>
<td>s</td>
</tr>
<tr>
<td>peak energy</td>
<td>75 eV (16.5 nm)</td>
</tr>
<tr>
<td>peak reflectivity</td>
<td>46.0%</td>
</tr>
<tr>
<td>bandwidth (FWHM)</td>
<td>2.6 eV (0.6 nm)</td>
</tr>
</tbody>
</table>
**NBR-70-1.9**

<table>
<thead>
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<th>NRB-70-1.9</th>
</tr>
</thead>
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<td>AOI</td>
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</tr>
<tr>
<td>polarization</td>
<td>s</td>
</tr>
<tr>
<td>peak energy</td>
<td>70 eV (17.7 nm)</td>
</tr>
<tr>
<td>peak reflectivity</td>
<td>43.7%</td>
</tr>
<tr>
<td>bandwidth (FWHM)</td>
<td>1.9 eV (0.5 nm)</td>
</tr>
</tbody>
</table>

**NBR-65-2.1**

<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>AOI</td>
<td>5 deg</td>
</tr>
<tr>
<td>polarization</td>
<td>s</td>
</tr>
<tr>
<td>peak energy</td>
<td>65 eV (19.1 nm)</td>
</tr>
<tr>
<td>peak reflectivity</td>
<td>43.5%</td>
</tr>
<tr>
<td>bandwidth (FWHM)</td>
<td>2.1 eV (0.6 nm)</td>
</tr>
</tbody>
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### NBR-60-2.2

<table>
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<th>NRB-60-2.2</th>
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<tbody>
<tr>
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</tr>
<tr>
<td>polarization</td>
<td>s</td>
</tr>
<tr>
<td>peak energy</td>
<td>60 eV (20.7 nm)</td>
</tr>
<tr>
<td>peak reflectivity</td>
<td>42.2%</td>
</tr>
<tr>
<td>bandwidth (FWHM)</td>
<td>2.2 eV (0.8 nm)</td>
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</tbody>
</table>

### NBR-55-2.4

<table>
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<tbody>
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<td>5 deg</td>
</tr>
<tr>
<td>polarization</td>
<td>s</td>
</tr>
<tr>
<td>peak energy</td>
<td>55 eV (22.5 nm)</td>
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<tr>
<td>peak reflectivity</td>
<td>38.4%</td>
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<tr>
<td>bandwidth (FWHM)</td>
<td>2.4 eV (1 nm)</td>
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</table>
**NBR-50-2.7**

<table>
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<th>NRB-50-2.7</th>
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<tbody>
<tr>
<td>AOI</td>
<td>5 deg</td>
</tr>
<tr>
<td>polarization</td>
<td>s</td>
</tr>
<tr>
<td>peak energy</td>
<td>50 eV</td>
</tr>
<tr>
<td>peak reflectivity</td>
<td>33.5%</td>
</tr>
<tr>
<td>bandwidth (FWHM)</td>
<td>2.7 eV</td>
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**NBR-48-1.3**

<table>
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<tbody>
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</tr>
<tr>
<td>polarization</td>
<td>s</td>
</tr>
<tr>
<td>peak energy</td>
<td>48 eV</td>
</tr>
<tr>
<td>peak reflectivity</td>
<td>49.2%</td>
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<tr>
<td>bandwidth (FWHM)</td>
<td>1.3 eV</td>
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</table>
### NBR-45-1.5

<table>
<thead>
<tr>
<th>Design name</th>
<th>NRB-45-1.5</th>
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</thead>
<tbody>
<tr>
<td>AOI</td>
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<tr>
<td>polarization</td>
<td>s</td>
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<tr>
<td>peak energy</td>
<td>45 eV (27.6 nm)</td>
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<tr>
<td>peak reflectivity</td>
<td>47.6%</td>
</tr>
<tr>
<td>bandwidth (FWHM)</td>
<td>1.5 eV (0.9 nm)</td>
</tr>
</tbody>
</table>

### NBR-40-1.5

<table>
<thead>
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<th>NNR-40-1.5</th>
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<tbody>
<tr>
<td>AOI</td>
<td>5 deg</td>
</tr>
<tr>
<td>polarization</td>
<td>s</td>
</tr>
<tr>
<td>peak energy</td>
<td>40 eV (31 nm)</td>
</tr>
<tr>
<td>peak reflectivity</td>
<td>44.8%</td>
</tr>
<tr>
<td>bandwidth (FWHM)</td>
<td>1.5 eV (1.1 nm)</td>
</tr>
</tbody>
</table>
### NBR-35-1.6

<table>
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<th>NRB-35-1.6</th>
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</tr>
<tr>
<td>polarization</td>
<td>s</td>
</tr>
<tr>
<td>peak energy</td>
<td>35 eV (35.4 nm)</td>
</tr>
<tr>
<td>peak reflectivity</td>
<td>43.7%</td>
</tr>
<tr>
<td>bandwidth (FWHM)</td>
<td>1.6 eV (1.6 nm)</td>
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### NBR-30-1.9

<table>
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<th>NNR-30-1.9</th>
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<tbody>
<tr>
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</tr>
<tr>
<td>polarization</td>
<td>s</td>
</tr>
<tr>
<td>peak energy</td>
<td>30 eV (41.3 nm)</td>
</tr>
<tr>
<td>peak reflectivity</td>
<td>42.0%</td>
</tr>
<tr>
<td>bandwidth (FWHM)</td>
<td>1.9 eV (2.6 nm)</td>
</tr>
</tbody>
</table>
Design name | NRB45-90-3.1
--- | ---
AOI | 45 deg
polarization | s
peak energy | 90 eV (13.8 nm)
peak reflectivity | 53.2%
bandwidth (FWHM) | 3.1 eV (0.5 nm)

Design name | NNR45-70-2.6
--- | ---
AOI | 45 deg
polarization | s
peak energy | 70 eV (17.7 nm)
peak reflectivity | 45.6%
bandwidth (FWHM) | 2.6 eV (0.7 nm)
### Design name: **NRB45-40-2.9**

<table>
<thead>
<tr>
<th><strong>AOI</strong></th>
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</tr>
</thead>
<tbody>
<tr>
<td><strong>polarization</strong></td>
<td>s</td>
</tr>
<tr>
<td><strong>peak energy</strong></td>
<td>40 eV (31 nm)</td>
</tr>
<tr>
<td><strong>peak reflectivity</strong></td>
<td>46.5%</td>
</tr>
<tr>
<td><strong>bandwidth (FWHM)</strong></td>
<td>2.9 eV (2.2 nm)</td>
</tr>
</tbody>
</table>
Broadband XUV MLMs are used as attosecond pulse focusing, attosecond pulsed measurements, astronomy, and plasma physics.

<table>
<thead>
<tr>
<th>No</th>
<th>design name</th>
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<th>pol.</th>
<th>peak energy</th>
<th>reflectivity</th>
<th>bandwidth (FWHM)</th>
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<tbody>
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<td>BBR-80-30</td>
<td>5 deg</td>
<td>s</td>
<td>80 eV (15.5 nm)</td>
<td>5.1%</td>
<td>30 eV (6.1 nm)</td>
</tr>
<tr>
<td>44</td>
<td>BBR-70-27</td>
<td>5 deg</td>
<td>s</td>
<td>70 eV (17.7 nm)</td>
<td>8.1%</td>
<td>27 eV (7.3 nm)</td>
</tr>
<tr>
<td>45</td>
<td>BBR-60-24</td>
<td>5 deg</td>
<td>s</td>
<td>60 eV (20.7 nm)</td>
<td>9.8%</td>
<td>24 eV (8.6 nm)</td>
</tr>
<tr>
<td>46</td>
<td>UBBR-55-39</td>
<td>5 deg</td>
<td>s</td>
<td>55 eV (22.5 nm)</td>
<td>6.8%</td>
<td>39 eV (16.3 nm)</td>
</tr>
<tr>
<td>47</td>
<td>UBBR-50-34</td>
<td>5 deg</td>
<td>s</td>
<td>50 eV (24.8 nm)</td>
<td>6.7%</td>
<td>34 eV (18.6 nm)</td>
</tr>
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</table>
### BBR-80-30

<table>
<thead>
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<th>BBR-80-30</th>
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<tbody>
<tr>
<td>AOI</td>
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</tr>
<tr>
<td>polarization</td>
<td>s</td>
</tr>
<tr>
<td>peak energy</td>
<td>80 eV     (15.5 nm)</td>
</tr>
<tr>
<td>peak reflectivity</td>
<td>5.1%</td>
</tr>
<tr>
<td>bandwidth (FWHM)</td>
<td>30 eV   (6.1 nm)</td>
</tr>
</tbody>
</table>

### BBR-70-27

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<th>BBR-70-27</th>
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<tbody>
<tr>
<td>AOI</td>
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</tr>
<tr>
<td>polarization</td>
<td>s</td>
</tr>
<tr>
<td>peak energy</td>
<td>70 eV     (17.7 nm)</td>
</tr>
<tr>
<td>peak reflectivity</td>
<td>8.1%</td>
</tr>
<tr>
<td>bandwidth (FWHM)</td>
<td>27 eV   (7.3 nm)</td>
</tr>
</tbody>
</table>
### BBR-60-24

<table>
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<tr>
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<tbody>
<tr>
<td>AOI</td>
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</tr>
<tr>
<td>polarization</td>
<td>s</td>
</tr>
<tr>
<td>peak energy</td>
<td>60 eV (20.7 nm)</td>
</tr>
<tr>
<td>peak reflectivity</td>
<td>9.8%</td>
</tr>
<tr>
<td>bandwidth (FWHM)</td>
<td>24 eV (8.6 nm)</td>
</tr>
</tbody>
</table>

![Graph of BBR-60-24](image1.png)

### UBBR-55-39

<table>
<thead>
<tr>
<th>Design name</th>
<th>UBBR-55-39</th>
</tr>
</thead>
<tbody>
<tr>
<td>AOI</td>
<td>5 deg</td>
</tr>
<tr>
<td>polarization</td>
<td>s</td>
</tr>
<tr>
<td>peak energy</td>
<td>55 eV (22.5 nm)</td>
</tr>
<tr>
<td>peak reflectivity</td>
<td>6.8%</td>
</tr>
<tr>
<td>bandwidth (FWHM)</td>
<td>39 eV (16.3 nm)</td>
</tr>
</tbody>
</table>

![Graph of UBBR-55-39](image2.png)
**Design name** | **UBBR-50-34**
--- | ---
AOI | 5 deg
polarization | s
peak energy | 50 eV (24.8 nm)
peak reflectivity | 6.7%
bandwidth (FWHM) | 34 eV (18.6 nm)
<table>
<thead>
<tr>
<th>Substrate specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size (diameter or with and length)</td>
</tr>
<tr>
<td>Surface figure (flat, concave, convex, …)</td>
</tr>
<tr>
<td>Radius of curvature (or focal length)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Multilayer specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Central photon energy (or central wavelength)</td>
</tr>
<tr>
<td>Bandwidth (FWHM) (eV or nm)</td>
</tr>
<tr>
<td>Normal incident angle</td>
</tr>
<tr>
<td>Materials (if required)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Other requirements</th>
</tr>
</thead>
</table>

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