FrameStar® two-component technology reduces evaporation from PCR plates, improving results and allowing for volume reductions to save money.

“FrameStar® plates led to significantly better results and reduced evaporation compared to standard PCR plates.”

Dr. Andreas Dahl, MPI f. Molekulare Genetik, Berlin, Germany

FrameStar® PCR plates maximise thermal stability at high temperatures which prevents sample loss by minimising thermal expansion during PCR. The two-component design combines the advantages of thin wall polypropylene tubes for optimum PCR results and a rigid polycarbonate skirt and deck for highest thermal stability and rigidity. In contrast to standard one piece PCR plates evaporation from corner positions and outside rows of wells is minimal which allows for downsampling of reagent volumes and saves costly reagents.

- Improved PCR results
- Minimised sample loss
- No increase of sample evaporation from corner wells
- Recommended for low volume PCR
- Thin-wall design for fast PCR
- Cost saving through downsampling of reaction volumes
- Ideal for robotics, as plate distortion eliminated post PCR

FrameStar PCR plates are covered by one or more of the following U.S. patents or their foreign counterparts, owned by Eppendorf AG: US Patent Nos. 7,347,977 and 6,340,589.
Thermal expansion of Polypropylene (PP) plates leads to evaporation from outside wells.

PP is the optimum material for PCR tubes. It provides the most efficient heat transfer, as well as an inert surface with low binding capabilities for nucleic acids, proteins and other molecules. However, the material is not thermally stable in a plate format and expands and contracts during each PCR cycle (Figure 1). Such thermal expansion will weaken the plate seal and leads to sample evaporation mainly from corner wells and outside rows.

**FrameStar® 2-component technology reduces thermal expansion and sample evaporation**

The polycarbonate frame of FrameStar® plates is more heat resistant than standard PP plates which reduces thermal expansion to a minimum. For this reason the seal integrity remains intact even at elevated temperatures during PCR.

To illustrate this advantage of our two-component technology we have compared evaporation from one piece PP plates and FrameStar® PCR plates: Each well of a non-skirted 96well plate (single piece, PP) and a FrameStar® non-skirted design (code 4ti-0710) was filled with 10µl H2O. The plates were sealed with a QPCR adhesive (code 4ti-0560) and the weight of plates was measured before and after performing PCR (30 cycles x 15° 95°C; 15° 55°C).

Table 1 shows that the average volume loss from one piece PP plates was 2.3µl per well which is equal to 23% of the total reaction volume. In contrast the volume loss from FrameStar plates was only 0.49µl per well.

<table>
<thead>
<tr>
<th>Plate Type</th>
<th>Starting weight</th>
<th>Weight post PCR</th>
<th>Weight loss</th>
<th>Volume loss total/per well</th>
</tr>
</thead>
<tbody>
<tr>
<td>Framestar 4ti-0710</td>
<td>26.678g</td>
<td>26.631g</td>
<td>0.047g</td>
<td>47µl/0.49µl</td>
</tr>
<tr>
<td>One piece</td>
<td>17.807g</td>
<td>17.586g</td>
<td>0.221g</td>
<td>221µl/2.3µl</td>
</tr>
</tbody>
</table>

Table 1: Weight and volume loss from 96well PCR plates. Results shown are averages from 5 plates of each plate type. One piece PP plates showed more than 4 times higher volume loss than FrameStar® plates.

“Reducing the SyBr Green consumption by 40% means considerable cost savings to us.”

Carolin Deiner, PhD

“For our low volume real-time PCR assays the optimal combination we found were the 4titude® two component “FrameStar®” 384well PCR plates in combination with heat sealing.”

Dr. Andreas Dahl, MPI f. Molekulare Genetic, Berlin, Germany
FrameStar® PCR plates minimise sample loss across the plate

Evaporation from one piece PP plates is highest in the outer wells

Since thermal expansion and movement of wells in one piece PP plates is enhanced around the edges of the plates (see Figure 1) evaporation is the highest from the two outer rows of wells. Figure 3 illustrates the levels of sample evaporation from different areas of PP plates. Only the inner 32 wells of a one piece 96well plate show low levels of evaporation but sample loss is high from the two outside rows which contain more than 65% of the wells.

FrameStar® 2-component plates improve consistency of PCR results

We have compared the degree of evaporation from different areas of one piece PP and FrameStar® PCR plates. First, the 64 outer wells (two outside rows) of both plate types were filled with 10μl H₂O, plates were then sealed with a QPCR adhesive (code 4ti-0560) and their total weight determined before and after PCR. The experiment was repeated with a set of plates of which the inner 32 wells (green area in Figure 3) were filled. Table 2 shows that evaporation from outer wells of standard PP plates was significant and 65% higher than from inner wells. In contrast, FrameStar plates showed low levels of sample loss across the plate.

<table>
<thead>
<tr>
<th>Plate Type</th>
<th>Starting weight</th>
<th>Weight post PCR</th>
<th>Weight loss</th>
<th>Volume loss total/per well</th>
</tr>
</thead>
<tbody>
<tr>
<td>Framestar 4ti-0710 outer 64 wells</td>
<td>26.230g</td>
<td>26.193g</td>
<td>0.037g</td>
<td>37μl/0.57μl</td>
</tr>
<tr>
<td>One piece, outer 64 wells</td>
<td>17.299g</td>
<td>17.118g</td>
<td>0.181g</td>
<td>181μl/2.8μl</td>
</tr>
<tr>
<td>Framestar 4ti-0710 inner 32 wells</td>
<td>25.841g</td>
<td>25.824g</td>
<td>0.017g</td>
<td>17μl/0.53μl</td>
</tr>
<tr>
<td>One piece, inner 32 wells</td>
<td>17.132g</td>
<td>17.078g</td>
<td>0.054g</td>
<td>54μl/1.69μl</td>
</tr>
</tbody>
</table>

Table 2: Weight and volume loss from different sections of 96well PCR plates. Results shown are averages from 5 plates of each plate type. Volume loss from the outside wells of one piece PP plates was 5-times higher than from FrameStar® plates.

The above results show that reaction volumes remain consistent across the 96wells (or 384wells, data not shown) in FrameStar® plates. In contrast, the reaction volumes in standard plates will differ increasingly between wells during PCR. Buffer concentrations in outside rows will increase dramatically and result in reduced enzyme activity. In extreme cases samples will fully evaporate.

FrameStar® 2-component technology allows for reduction of assay volumes and cost

Due to the much improved seal integrity, reaction volumes can often be reduced when using FrameStar® plates. Such downscaling of experiments can be successfully implemented without any loss of assay sensitivity or consistency (Figure 4) and reagent savings can be considerable.

Figure 3: Evaporation from the outside rows (red) is highest, medium level evaporation occurs in the second row (yellow) and sample loss from the inner 32 wells is lowest.

Figure 4: Comparable Ct Values and mean deviations were obtained with 15μl and 25μl SyBr Green assays in heat sealed FrameStar® plates.
**PRODUCT RANGE**

<table>
<thead>
<tr>
<th>FrameStar 384:</th>
<th>FrameStar 96 with upstand:</th>
</tr>
</thead>
<tbody>
<tr>
<td>384well plate, ideal for robotic use.</td>
<td>96well semi-skirted plate with upstand, standard profile, designed to fit ABI thermal cyclers and sequencers.</td>
</tr>
<tr>
<td><strong>Plate code A</strong></td>
<td><strong>Plate code F</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>FrameStar 480/384:</th>
<th>FrameStar 96 semi-skirted (cut corner A12):</th>
</tr>
</thead>
<tbody>
<tr>
<td>384well, designed for the Roche LightCycler® 480.</td>
<td>96well semi-skirted plate, standard profile, A12 cut corner to fit ABI instruments.</td>
</tr>
<tr>
<td><strong>Plate Code B</strong></td>
<td><strong>Plate Code G</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>FrameStar 96 skirted low profile:</th>
<th>FrameStar 96 semi-skirted (cut corner H1):</th>
</tr>
</thead>
<tbody>
<tr>
<td>96well plate, low profile, recommended for robotics and low volume PCR.</td>
<td>96well semi-skirted plate, standard profile, cut corner H1, designed for universal fit.</td>
</tr>
<tr>
<td><strong>Plate Code C</strong></td>
<td><strong>Plate Code H</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>FrameStar 480/96 semi-skirted:</th>
<th>FrameStar 96 non-skirted:</th>
</tr>
</thead>
<tbody>
<tr>
<td>96well plate, low profile, designed for the Roche LightCycler® 480.</td>
<td>96well plate, standard profile, fits most thermal cyclers.</td>
</tr>
<tr>
<td><strong>Plate Code D</strong></td>
<td><strong>Plate Code I</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>FrameStar FastPlate 96 semi-skirted low profile:</th>
<th>FrameStar 96 non-skirted low profile:</th>
</tr>
</thead>
<tbody>
<tr>
<td>96well plate, low profile, recommended for ABI Fast Block cyclers.</td>
<td>96well plate, low profile, recommended for low volume PCR.</td>
</tr>
<tr>
<td><strong>Plate Code E</strong></td>
<td><strong>Plate Code J</strong></td>
</tr>
</tbody>
</table>

### Ordering Information

Choose plate type from selection above and obtain Plate Code. Choose colour combination required and obtain Part Number.

<table>
<thead>
<tr>
<th>Plate Code (from above)</th>
<th>Purple Frame</th>
<th>Blue Frame</th>
<th>Clear Frame</th>
<th>Green Frame</th>
<th>Red Frame</th>
<th>Black Frame</th>
<th>Black Frame</th>
<th>Clear Frame</th>
</tr>
</thead>
<tbody>
<tr>
<td>B</td>
<td>4ti-0384</td>
<td>4ti-0384/C</td>
<td>4ti-0950/C</td>
<td>4ti-0950/G</td>
<td>4ti-0960/R</td>
<td>4ti-0960/4</td>
<td>4ti-0961</td>
<td>4ti-0951</td>
</tr>
<tr>
<td>C</td>
<td>4ti-0960</td>
<td>4ti-0960/B</td>
<td>4ti-0960/C</td>
<td>4ti-0960/G</td>
<td>4ti-0960/R</td>
<td>4ti-0960/4</td>
<td>4ti-0961</td>
<td>4ti-0951</td>
</tr>
<tr>
<td>I</td>
<td>4ti-0710</td>
<td>4ti-0710/B</td>
<td>4ti-0710/C</td>
<td>4ti-0710/G</td>
<td>4ti-0710/R</td>
<td>4ti-0710/4</td>
<td>4ti-0711</td>
<td>4ti-0711</td>
</tr>
</tbody>
</table>

All pack sizes are 50 plates per case.

See [www.4ti.co.uk/technical/compatibility.php](http://www.4ti.co.uk/technical/compatibility.php) for compatibility with thermal cyclers & sequencers.

All skirted plates are available with linear barcodes. Please see [www.4ti.co.uk/technical/barcode.php](http://www.4ti.co.uk/technical/barcode.php) for further details and a custom order form.

**TATAA Biocenter**

Odinsgatan 28,
411 03 Göteborg
Sweden

order@tataa.com