Physics-Aware Image-to-Image Translation to Explore Long-Life All-Solid-State Batteries
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Background: Battery Degradation
Deciphering the battery degradation patterns from microscope images to prolong battery life
Development of computer vision for microscope

Phases of the methodology:

**PHASE 1: Multitask learning**
- Mixture of experts
- Modality-invariant fingerprint
- Multitask decoder

**PHASE 2: Cross-domain learning**
- Pre-cycling
- Fingerprint of degradation
- Post-cycling

**PHASE 3: Metric learning**
- Degradation atlas
- Microcracking

Image-to-Image Translation Model

Degradation Patterns Recognition

<table>
<thead>
<tr>
<th>Degradation Patterns</th>
<th>Average</th>
<th>Classification accuracy</th>
<th>Prediction $R^2$ score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ground Truth CycleGAN</td>
<td>98.33</td>
<td>96.75</td>
<td>83.90</td>
</tr>
<tr>
<td>Ours w/o SSCL</td>
<td>48.46</td>
<td>96.51</td>
<td>83.60</td>
</tr>
<tr>
<td>Ours w/o classification</td>
<td>49.06</td>
<td>97.81</td>
<td>0.30</td>
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<tr>
<td>Only classification</td>
<td></td>
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<tr>
<td>Only prediction</td>
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<tr>
<td>CycleGAN</td>
<td>10.97</td>
<td>19.84</td>
<td>2.10</td>
</tr>
</tbody>
</table>

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Development of computer vision for microscope

Exploration Results

Cycle number vs. Capacity (mAh/g)

Degradation patterns from microscope images to prolong battery life
Development of computer vision for microscope

Transforming Models

Degradation Patterns

I. Fracture
II. Vertical crack
III. Fragmentation
IV. Microcracking
V. Shell void

Exploration Results

Input #1
predicted interpolated images
Input #2
generated images
measured SEM images
experimentally explored