**Electrically pumped single photon source in diamond**

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**Why Single Photon Sources in Diamond?**

NV and SiV centers in diamond show special characteristics like single photon emission with high photostability at room temperature. Due to these properties, they are of particular interest for future technologies such as quantum computing (NV), information processing and cryptography (SiV) [1]. Our research focuses on the realization of single photon sources into electrical circuits in order to make them usable for quantum communication.

<table>
<thead>
<tr>
<th></th>
<th>GaN</th>
<th>Diamond</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bandgap [eV]</td>
<td>3.42</td>
<td>5.45</td>
</tr>
<tr>
<td>Breakdown field [MV/cm]</td>
<td>2</td>
<td>10</td>
</tr>
<tr>
<td>Thermal conductivity [W/cmK]</td>
<td>1.5</td>
<td>22</td>
</tr>
</tbody>
</table>

Diamond properties are remarkably superior to other semiconductors considering its use in power electronic devices. Here, the most important properties of diamond are compared to those of GaN.

**NV and SiV centers as Single Photon Source**

The nitrogen-vacancy (NV) center is one of the best characterized defect centers:

- Stable single photon emission
- Broadband emission in the visible range at 575 - 800 nm [2]
- Extraordinary long spin coherence times
- Optically detected magnetic resonance

SiV centers are an alternative to NV centers:

- Photostability
- Narrow emission line in near infrared at 738 nm [3]

**Properties of pin-Diodes**

After growth, pillar structures of different sizes and shapes are etched into the n-layer of the pin-diode for improving the electrical contacting of the diodes.

**CVD-Growth**

High quality (111) diamond films are grown in ellipsoidal micro-wave plasma enhanced chemical vapor deposition reactors developed by IAF.

We are able to grow intrinsic as well as p- (boron doped) and n-type (phosphorus doped) layers.

**Quantum Applications**

Generation of single centers (single photon emitter) by ion beam implantation or by in-situ gas phase doping during growth:

- Photostability
- Extraordinary long spin coherence times
- Broadband emission in the visible range

The nitrogen-vacancy (NV) center is one of the best characterized defect centers. Due to these properties, they are of particular interest for future technologies such as quantum computing (NV), information processing and cryptography (SiV) [1].

**Layers**

<table>
<thead>
<tr>
<th>Layer</th>
<th>Thickness (typ.)</th>
<th>Density (cm$^{-3}$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>n-type</td>
<td>1-2 μm</td>
<td>$[P] = 10^{17}$-$10^{18}$</td>
</tr>
<tr>
<td>i-type</td>
<td>1-15 μm</td>
<td>$[N,B] = 10^{14}$</td>
</tr>
<tr>
<td>p-type</td>
<td>300 μm</td>
<td>$[B] = 10^{17}$-$10^{18}$</td>
</tr>
</tbody>
</table>

Thicknesses and doping concentrations are varied in the growth process depending on the desired device properties.

**References:**


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**Tunable light emission in pin-structure:**

Reverse bias (0 to -100 V): Intensity of NV- slightly decreasing. Forward bias (0 to +35 V): Ratio of NV- to NV$^0$ drastically changes.

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**References:**