Supporting Information

Experimental optical properties of single nitrogen vacancy centers in silicon carbide at room temperature

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In order to confirm the different bunching effect of the single NV centers, we also study the laser-power dependent correlation measurements of another six emitters. Figure S1 shows the confocal image of the measured 8 representative single NV centers, which including four basal (NV-1, NV-2, NV-6, NV-8) and four c-axis NV centers (NV-13, NV-14, NV-15, NV-17). Fig. S2 and Fig. S3 show the fitting parameters of $g^2(\tau)$ of three basal and three c-axis NV centers, respectively. Table S1 shows the decay rates of the three basal and three c-axis NV centers deduced from fittings of the power-dependent second-order autocorrelation functions. The inferred lifetimes of the single NV centers range from 2.3 to 2.7 ns, which are consistent with the measured NV center ensemble lifetime (around 2.5 ns) [See Fig. 4d in the main text].

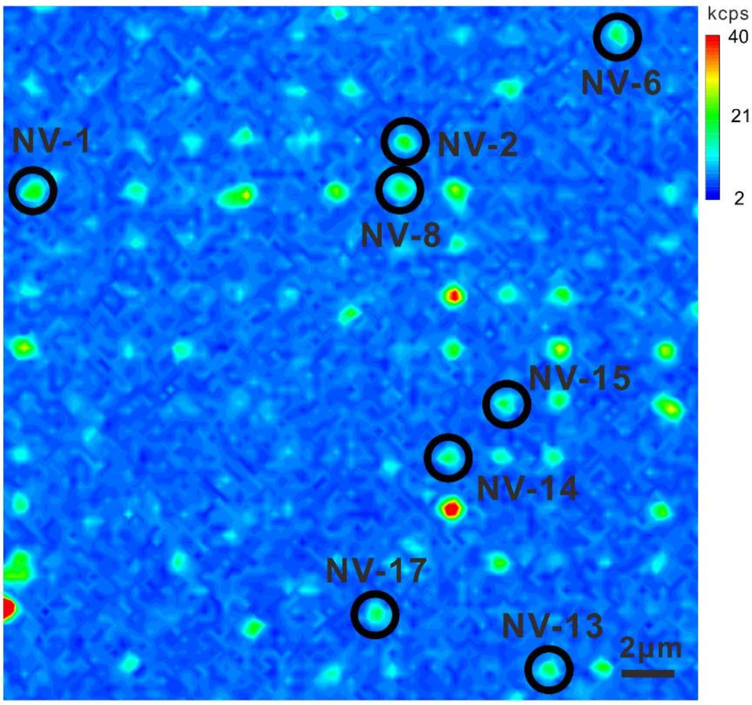

Figure S1 The confocal image of the 8 single NV centers, which including four basal (NV-1, NV-2, NV-6, NV-8) and four c-axis NV centers (NV-13, NV-14, NV-15, NV-17).

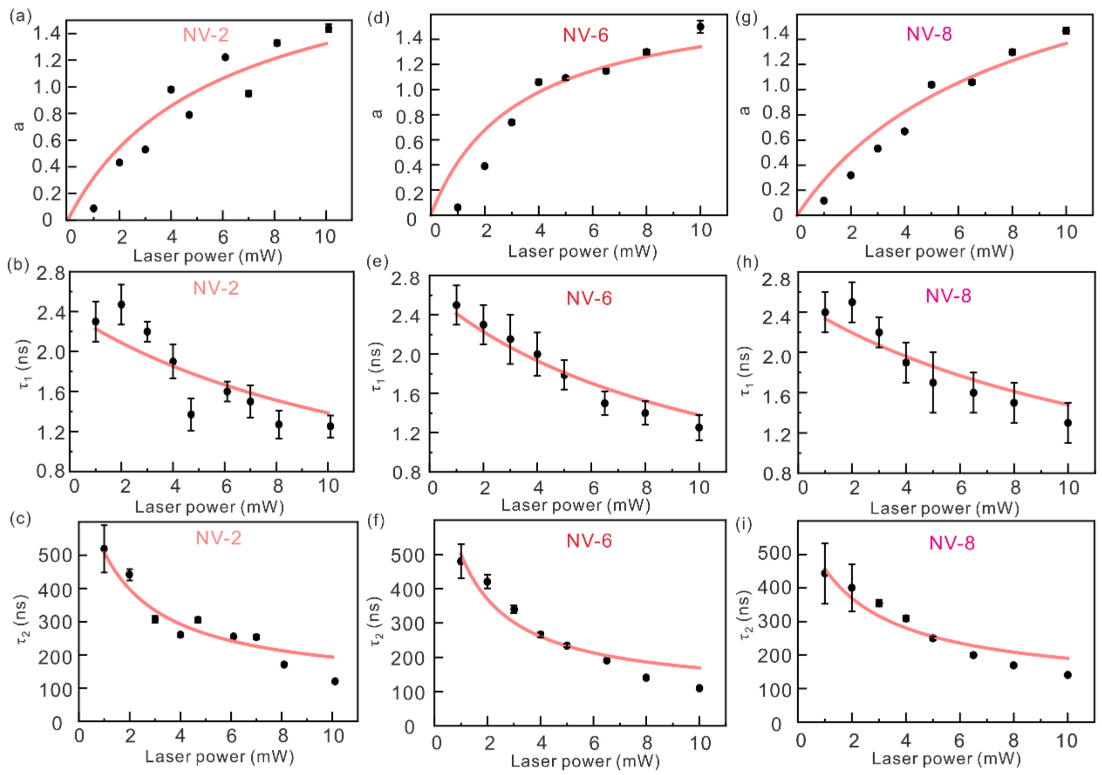

Figure S2 Fitting parameters a, τ_1 and τ_2 of the laser power dependent correlation function $g^2(\tau)$ for three basal NV centers NV-2, NV-6 and NV-8 respectively.

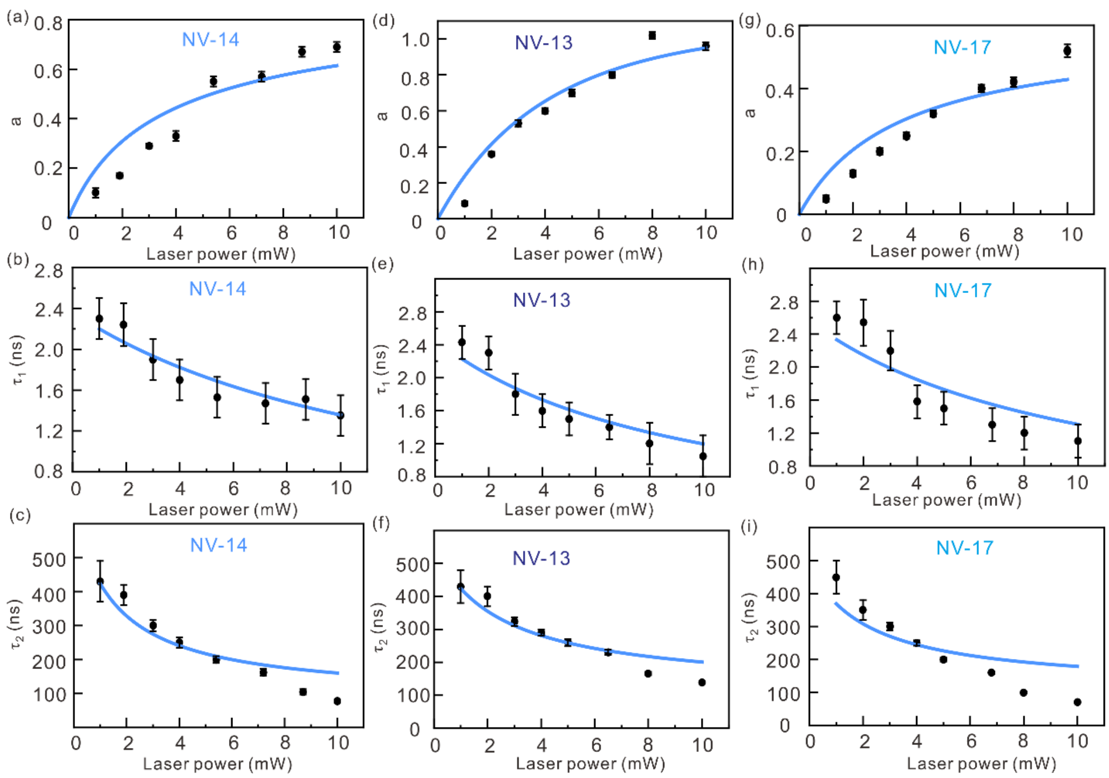

Figure S3 Fitting parameters a, τ_1 and τ_2 of the laser power dependent correlation function $g^2(\tau)$ for three c-axis NV centers NV-13, NV-14 and NV-17 respectively.

Table S1. Decay rates of the three basal NV centers (NV-2, NV-6, NV-8; Red) and three c-axis NV centers (NV-13, NV-14, NV-17; Blue) deduced from fittings of the power-dependent second-order autocorrelation functions.

NV center	$1/k_{21}$(ns)	$1/k_{23}$(ns)	$1/k_{31}(0)$ (ns)	$1/k_{31}(\infty)$(ns)	lifetime(ns)
NV-2	2.43	145.02	752.25	319.24	2.3
NV-6	2.68	142.92	863.47	255.68	2.6
NV-8	2.54	136.28	625.81	349.64	2.5
NV-13	2.49	214.51	550.11	178.58	2.5
NV-14	2.39	182.72	640.97	161.60	2.3
NV-17	2.58	296.33	484.47	176.56	2.6

Moreover, we also investigate the statistics on the NV center numbers per spot for 100 spots, which is shown in Figure S4. The red point is the fitting using the Possion distribution function. The single NV creation yield is around 29 %. The average number of NV center per aperture is around 0.4, and the implanted dose corresponds to 10 nitrogen ions per aperture. As a result, the conversion yields of the implanted nitrogen ions into the NV center is about 4 %.

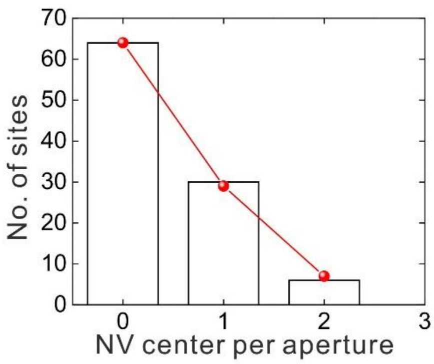

Figure S4 The statistics on the NV center numbers for 100 spots.

Additionally, we also measure the photon counts of ensemble NV centers (dose $1\times10^{14}/cm^2$) as a function of the temperature [See Fig. S5], which is similar with the results of single NV center and previous NV center ensembles[1]. The decreasing of the fluorescence counts maybe also due to the effect of competing non-radiative recombination pathways and energy transfer from NV center to other neighboring defects[1,2]. The activation energy E for NV ensembles is deduced to 0.16± 0.05 eV, which is consistent with that of single NV center (0.15 ± 0.02 eV) and previous ensemble results (0.14 eV)[1].

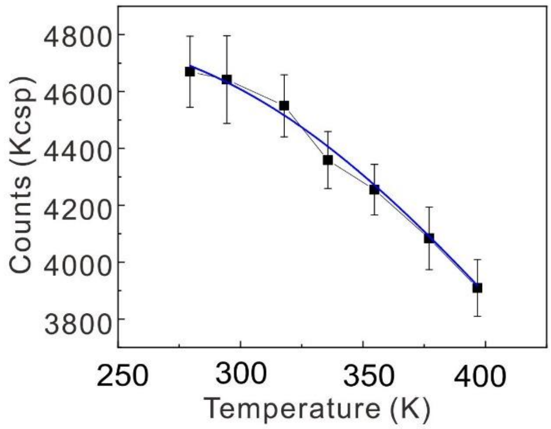

Figure S5 The counts of the ensemble NV centers as a function of the temperature. The blue line is the fitting of the data. Error bars represent the counting standard deviations.

References

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(2) Kianinia, M.; Tawfik, S. A.; Regan, B.; Tran, T. T.; Ford, M. J.; Aharonovich I.; Toth, M. Robust Solid State Quantum System Operating at 800 K, ACS Photonics, 2017, 4, 768.