Electronic Supplementary Information

Formation and Photochemical Properties of Aqueous Brown Carbon through Glyoxal Reactions with Glycine

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FTIR measurements of the samples were carried out by using a Thermo Scientific Nicolet 10 spectrometer, over 4000-400 cm⁻¹, at a resolution of 0.4 cm⁻¹.

Raman spectra of the brown carbon samples were recorded by the method similar to that reported by Wang et al. Brown carbon samples were discharged from a syringe. Then, the residual solutions in the syringe were pushed rapidly to generate aerosol droplets spraying onto a polytetrafluoroethylene (PTFE) substrate fixed to the bottom of the sample cell. The sample cell was promptly sealed with a transparent polyethylene film. Lastly, the aqueous brown carbon droplets with diameters of 30-40 µm detected by using an optical microscope (50 × objective, 0.75 numerical aperture) were selected to acquire Raman spectra.

**FTIR spectral properties**

FTIR spectra of Gly and the GX-Gly mixtures after subtracting the baseline are shown in Fig. S1. In this region, there are several peaks that can be assigned to the corresponding functional groups of Gly: \( \nu(\text{CN}) \) due to \( \sim 1092 \text{ cm}^{-1} \), \( \nu(-CH_2) \) due to \( \sim 1337 \text{ cm}^{-1} \), \( \nu_s(-COO^-) \) and \( \sim 1620 \text{ cm}^{-1} \) due to \( \omega(-NH_3^+) \). The FTIR spectra of Gly and the GX-Gly mixtures have very similar size distributions. Therefore, FTIR spectrum is unsuitable for detecting the formation of this kind of brown carbon mixtures.

![FTIR spectra of glycine (Gly) and the aqueous brown carbon aerosol from the GX-Gly mixtures.](image)

**Fig. S1** FTIR spectra of glycine (Gly) and the aqueous brown carbon aerosol from the GX-Gly mixtures.
Raman spectroscopy

Fig. S2 shows vibrational spectra of the un-reacted Gly and the brown carbon samples of the GX-Gly mixtures that were reacted for 23 days. In this region, the characteristic vibrational bands observed at 733 and 1384 cm$^{-1}$ are from the PTFE. The peaks that can be assigned to Gly include: ~895 cm$^{-1}$ due to $\nu$(CC) + $\nu$(CN), ~1332 cm$^{-1}$ due to $\omega$(CH$_2$) + $\nu$(CN), ~1414 cm$^{-1}$ due to $\nu$(COO) + $\nu$(CC), ~1631 cm$^{-1}$ due to $\delta$(NH$_3$) + $\nu$(COO), ~2972 cm$^{-1}$ due to $\nu$($\delta$(CH$_2$), ~3011 cm$^{-1}$ due to $\nu$($\delta$(CH$_2$)). No visible difference is observed in the Raman spectra of the samples studied.

![Raman spectra of Gly and the aqueous brown carbon from the GX-Gly mixtures.](image)

Notes and references

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