CLAIMS

1. A system comprising:

a tunable laser to emit a tunable excitation beam with a wavelength tuning range of 50 nm or less;

a wavelength sensor, in optical communication with the tunable laser, to measure a wavelength of the tunable excitation beam;

a band-edge filter, in optical communication with the tunable laser, to reject at least a portion of amplified spontaneous emission from the tunable laser, wherein a passband of the band-edge filter overlaps with the wavelength tuning range of the tunable laser;

a spectrally selective detector to detect a Raman signal emitted by a sample in response to excitation with the tunable excitation beam; and

a processor, operably coupled to the wavelength sensor and the spectrally selective detector, to determine a Raman spectrum of the sample based on the Raman signal and the wavelength of the tunable excitation beam.

2. The system of claim 1, wherein the wavelength tuning range is at most 35 nm, and a center wavelength of the tunable excitation beam is an ultraviolet (UV) wavelength.

3. The system of claim 2, wherein the processor is further configured to determine the Raman spectrum with a Raman shift of up to 4000 cm^{-1}.

4. The system of claim 1, wherein a center wavelength of the tunable excitation beam is a visible light wavelength.

5. The system of claim 1, wherein the processor is further configured to determine the Raman spectrum with a resolution finer than 1 nm.

6. The system of claim 1, wherein the tunable laser is configured to tune the tunable excitation beam across the wavelength tuning range in less than one second.

7. A method of detecting a target substance with a known Raman spectral response in a sample, the method comprising:

emitting a tunable excitation beam with a wavelength tuning range of 50 nm or less, the wavelength tuning range selected based on the known Raman spectral response;

applying the tunable excitation beam to the sample while measuring a wavelength of the tunable excitation beam;

detecting a Raman signal emitted by the sample in response to the tunable excitation beam;

determining a Raman spectrum of the sample based on the Raman signal and the wavelength of the tunable excitation beam; and

determining a presence or an absence of the target substance in the sample based on the Raman spectrum.

8. The method of claim 7, wherein the emitting includes emitting the tunable excitation beam with a center wavelength selected from an ultraviolet (UV) wavelength and a visible light wavelength.

9. The method of claim 8, wherein the wavelength tuning range is at most 35 nm, and wherein the determining the Raman spectrum includes determining the Raman spectrum with a Raman shift of up to 4000 cm^{-1}.

10. The method of claim 7, wherein the determining the Raman spectrum includes determining the Raman spectrum with a resolution finer than 1 nm.

11. A method of measuring a Raman spectrum of a sample, the method comprising:

emitting a swept laser beam from a tunable laser towards a sample;

collecting Raman light emitted by the sample in response to the nonlinearly swept laser beam;

transmitting the Raman light through a filter having a transmission that varies in wavelength as a function of an incidence angle of the Raman light on the filter;

detecting, with a detector, a spatial distribution of the Raman light; and

estimating the Raman spectrum of the sample based on the spatial distribution of the Raman light.

12. The method of claim 11, wherein a passband of the filter shifts to shorter wavelengths at larger values of the incidence angle.

13. The method of claim 11, wherein the transmission of the filter varies nonlinearly with the incidence angle.

14. The method of claim 11, wherein the filter is a photonic crystal filter.

15. The method of claim 11, wherein the emitting includes sweeping the laser beam over a set of excitation wavelengths,

wherein the detecting includes, for each excitation wavelength of the set of excitation wavelengths, detecting the spatial distribution of the Raman light emitted by the sample in response to that excitation wavelength to detect a set of spatial distributions of the Raman light, and

wherein estimating the Raman spectrum includes reconstructing the Raman spectrum based on the set of spatial distributions of the Raman light.

16. The method of claim 11, wherein the incidence angle is a first incidence angle of a set of incidence angles defined by the Raman light on the filter,

wherein the transmission of the filter is different for each incidence angle of the set of incidence angles, and

wherein the spatial distribution of the Raman light is a wavelength distribution that maps to the transmission of the filter.

17. A system, comprising:

a tunable laser to emit a swept laser beam towards a sample along a first axis;

a filter having a transmission that varies in wavelength as a function of an incidence angle of the Raman light on the filter, to receive and filter the Raman light;

a detector to receive the Raman light from the filter and to detect a spatial distribution of the Raman light; and

a processor, operably coupled to the detector, to estimate a Raman spectrum of the sample based on the spatial distribution of the Raman light.

18. The system of claim 17, wherein the transmission of the filter varies nonlinearly with the incidence angle.

19. The system of claim 17, wherein the tunable laser is further configured to emit the laser beam by sweeping the laser beam over a set of excitation wavelengths,

wherein the detector is further configured to detect the spatial distribution by detecting, for each excitation wavelength of the set of excitation wavelengths, the spatial distribution of the Raman light emitted by the sample in response to that excitation wavelength to detect a set of spatial distributions of the Raman light, and

wherein the processor is further configured to estimate the Raman spectrum by reconstructing the Raman spectrum based on the set of spatial distributions of the Raman light.

20. The method of claim 17, wherein the incidence angle is a first incidence angle of a set of incidence angles defined by the Raman light on the filter,

wherein the transmission of the filter is different for each incidence angle of the set of incidence angles, and

wherein the spatial distribution of the Raman light is a wavelength distribution that maps to the transmission of the filter.