CLAIMS

1. An apparatus comprising a fiber, the fiber comprising a hollow core for guiding radiation propagating through the fiber and a ring structure comprising a plurality of structures, wherein the plurality of structures comprises a plurality of anti-resonant elements surrounding the hollow core, the fiber being for receiving input radiation and broadening a frequency range of the input radiation so as to provide broadband output radiation, the apparatus further comprising:

a generating apparatus for providing a gas mixture within the hollow core;

wherein the gas mixture comprises:

a hydrogen component; and

a working component for broadening a frequency range of a received input radiation so as to provide the broadband output radiation.

2. An apparatus according to claim 1, wherein the broadband output radiation comprises a continuous range of radiation frequencies.

3. An apparatus according to any of the preceding claims, wherein the hydrogen component comprises at least one of hydrogen gas, deuterium gas, and tritium gas.

4. An apparatus according to any of the preceding claims wherein the working component comprises a noble gas.

5. An apparatus according to any of the preceding claims, wherein a fraction of the hydrogen component in the gas mixture is less than 70%, or optionally less than 50%, or optionally less than 10%, or optionally less than 2%.

6. An apparatus according to any of the preceding claims wherein the fiber is a photonic crystal fiber.

7. An apparatus according to any of the preceding claims, wherein

the plurality of structures comprises a plurality of capillaries, and wherein, optionally, the plurality of structures is arranged so that the structures do not touch any of the other structures, and/or wherein, optionally, the fiber comprises a single ring of anti-resonance elements.

8. An apparatus according to any of the preceeding claims, wherein the hydrogen component of the gas mixture increases lifetime of the plurality of structures, and wherein, optionally, a degradation of an output power performance after 1000 hours of operation does not exceed 2%.

9. A radiation source for providing broadband output radiation, the radiation source comprising:

the apparatus according to any of claims 1 to 8; and

an input radiation source configured to provide input radiation to the apparatus;

wherein the apparatus is configured to broaden the input radiation to provide the broadband output radiation.

10. A radiation source according to claim 9, wherein the broadband output radiation has an average power of at least 1W, or optionally a least 5W, or optionally at least 10W.

11. A radiation source according to any of claims 9 or 10 wherein the fraction of the hydrogen component in the gas mixture of the apparatus is sufficiently high so that the fiber has an average output power stability of at least 95% for more than 100 hours of operation.

12. A method of broadening a radiation frequency range, the method comprising:

providing an apparatus according to any of claims 1 – 8;

propagating input radiation through the hollow core fiber, wherein the interaction of the input radiation with the gas mixture inside the hollow core fiber causes broadening of the frequency range of the input radiation so as to produce broadband output radiation.

13. A metrology arrangement for determining a parameter of interest of a structure on a substrate, the metrology arrangement comprising:

a radiation source according to any of claims 9 to 11;

an illumination sub-system for illuminating the structure on the substrate using the broadband output radiation; and

a detection sub-system for detecting a portion of radiation scattered and/or reflected by the structure, and for determining the parameter of interest from said portion of radiation.

14. A metrology apparatus comprising the metrology arrangement according to claim 13.

15. A lithographic apparatus comprising the metrology arrangement according to claim 13.