Release mechanism of a miniaturized rubidium atom source for quantum technologies

Jannik Koch[1], Alexander Kassner[1], Folke Dencker[1], Marc Christopher Wurz[1]

[1] Institute of Micro Production Technology, Leibniz University Hanover, Garbsen, Germany

Many quantum technologies require a defined number of vapor-phase atoms of specific elements, such as rubidium, strontium, and ytterbium. In this work, the concept of a miniaturized atom source using rubidium as an atom species is presented (Figure 1). Pure Rb reacts directly with small amounts of water or oxygen. Therefore, Rb is encapsulated in an inert atmosphere. After pumping and baking the quantum system to an ultrahigh vacuum, a release mechanism is triggered. The source consists of three micromachined silicon components: a release chip, which triggers the opening mechanism of the source by heating a silicon membrane, an Rb reservoir chip with an integrated heater, which offers thermal insulation from the substrate and heats the Rb reservoir to increase the vapor pressure of Rb, and a bottom substrate chip. This study focused on the release mechanism of the atom source. The release was triggered by a sharp increase in temperature within milliseconds using a gold heater structure. A total of 18 different systems were tested, requiring a heating power of 26.3 +/- 4.2 W to initiate the opening of the membrane. Figure 2 shows an exemplary temperature-time diagram during heating and IR images of the resulting breakthrough of the silicon membrane.

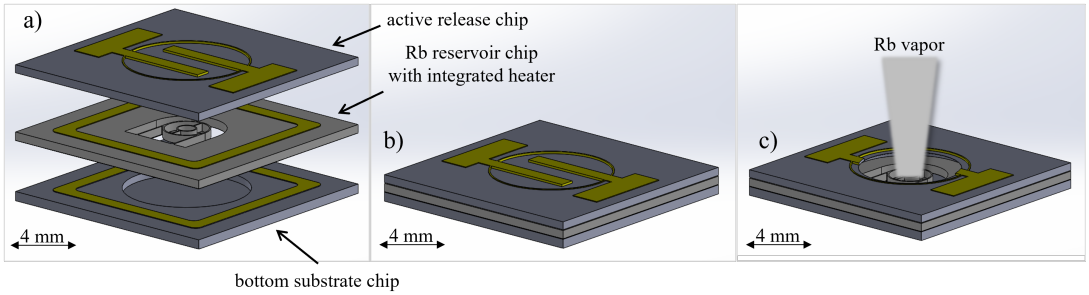

Figure 1. Schematic principle of the Rb source, a) different components of the source, b) the bonded source with encapsulated Rb and c) releasing of Rb after opening the source.

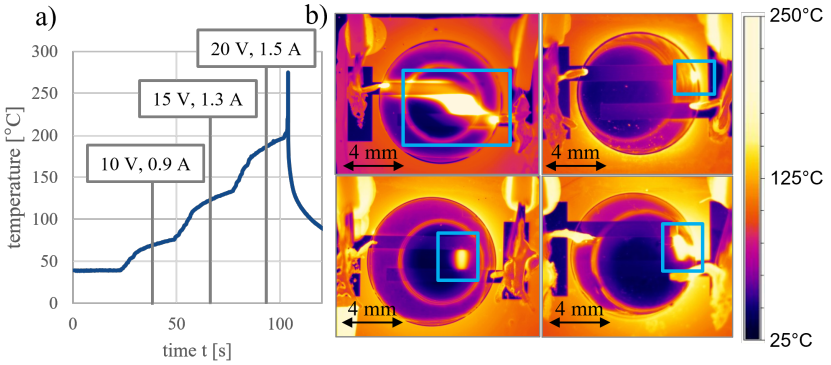

Figure 2. a) Exemplary temperature-time diagram during opening of the source and b) IR-images of the breakthrough of the silicon membrane by increasing the applied voltage