Sound Absorption In Small Listening Rooms:

As we have seen, the sound absorption $A = Sa$ (m^2) in a room depends primarily on the frequency-dependent absorptive properties associated with the materials used for the six surfaces of room – *i.e.* the walls, floor and ceiling. The Sabine formula tells us that the reverberation time T_{60} is proportional to the volume to surface area ratio, V/S. For small listening rooms, the volume to surface area ratio V/S is usually small (compared *e.g.* to a concert hall or auditorium) and hence the reverberation time T_{60} for a typical small room is usually quite short.

A home listening room usually also has furniture, whose upholstery adds significantly to the absorption A of the room, and often has a carpeted floor, which likewise contributes to the overall A of the room. When listening to recorded or broadcast music in a small home listening room, such music often has the accompanying reverberation signature of the concert hall or recording studio in which it was recorded. Thus, in order to fully appreciate the sonic ambience of the original recording, the listening room insofar as possible should be almost free of reverberation in order not to unduly “color”, or otherwise distort the sound of the original recording of the music.

Porous materials such as drapery/curtains, carpets, glass fiber and acoustical tile absorb sound energy very well at high frequencies, whereas materials commonly used in home construction such as wood, glass, gypsum board (drywall) and plaster on lath absorb sound energy very well at low frequencies. Thus, in afore-hand/custom home building, an architect-acoustician can consciously/deliberately design a quality home listening room by judicious choice of the design of the room and of the materials used in the construction of the room.

If room resonances, especially at low frequency, are problematic, another type of sound absorber that capitalizes on the {time-reversed!} principle of operation of a Helmholtz resonator can be used to provide sound absorption over a selected frequency band.

Recall that a Helmholtz resonator has a {fundamental} resonance frequency of $f_r = (v/2\pi)\sqrt{A_h/Vh'}$ where v = 343 m/s = speed of sound, $A_h = \pi r^2$ = cross sectional area (m^2) of the hole in the neck of the resonator, V = volume (m^3) of the resonator, $h' = h + \delta_{end}$ where h = length (m) of the neck of the resonator and $\delta_{end} \sim 1.7r$ is the so-called end correction. The Q-factor associated with the Helmholtz resonator is $Q_r = 2\pi\sqrt{V(h'/A)^3} = f_r/\Gamma_r$ where $\Gamma_r = f_r/Q_f = f_{hi} - f_{low} = FWHM$ of the resonance.

Sound energy from the room at/near the resonant frequency f_r of the Helmholtz resonator enters through the neck of the Helmholtz resonator and is trapped/stored inside it. By energy conservation, the energy stored in the Helmholtz resonator initially came from the room, thus there must be correspondingly less energy at this resonant frequency left in the room!