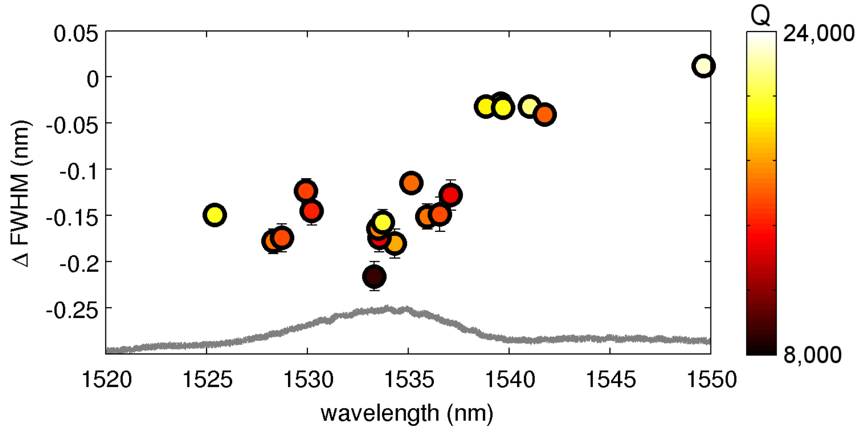

Fig. 7. (a) The change in linewidth between 5.5 K and room temperature, both measured at low pump powers (below 10 μW). The size of the points represents the intrinsic cavity Q-factor (Q_{cav}). The scaled and shifted Er spectrum is shown as a reference.

In conclusion, we have demonstrated that high Q-factor and low V_{mode} nanobeam cavities enable the observation of stimulated emission and optical transparency in an Er:SiN$_x$ material system. We have observed enhanced absorption and gain characteristics in the Er:SiN$_x$ compared to our previous work with a hybrid Er:SiN$_x$/Si PC cavity [6], due to the increased overlap of the cavity mode with the active Er material and the reduction of material losses. Finally, we have studied the pump power dependence of the cavities and observed linewidth narrowing. By comparing the cavity linewidths at room temperature and 5.5 K, and accounting for the enhancement of absorption using time-resolved measurements, we found that cavities have been pumped to transparency. Because cavity heating effects remain significant in such a cavity, material properties of the Er:SiN$_x$ layer may need to be adjusted to achieve higher inversion ratios. In addition, cavity designs with higher Q and lower V_{mode} may help achieve lasing by reducing the lasing threshold. In spite of such challenges, the observation of transparency due to stimulated emission in the Er:SiN$_x$ system is significant for future designs of lasers and amplifiers based in this material system.

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