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# The experiments of a two-stage pulse tube cryocooler with pressed Er-plated screen as regenerator material

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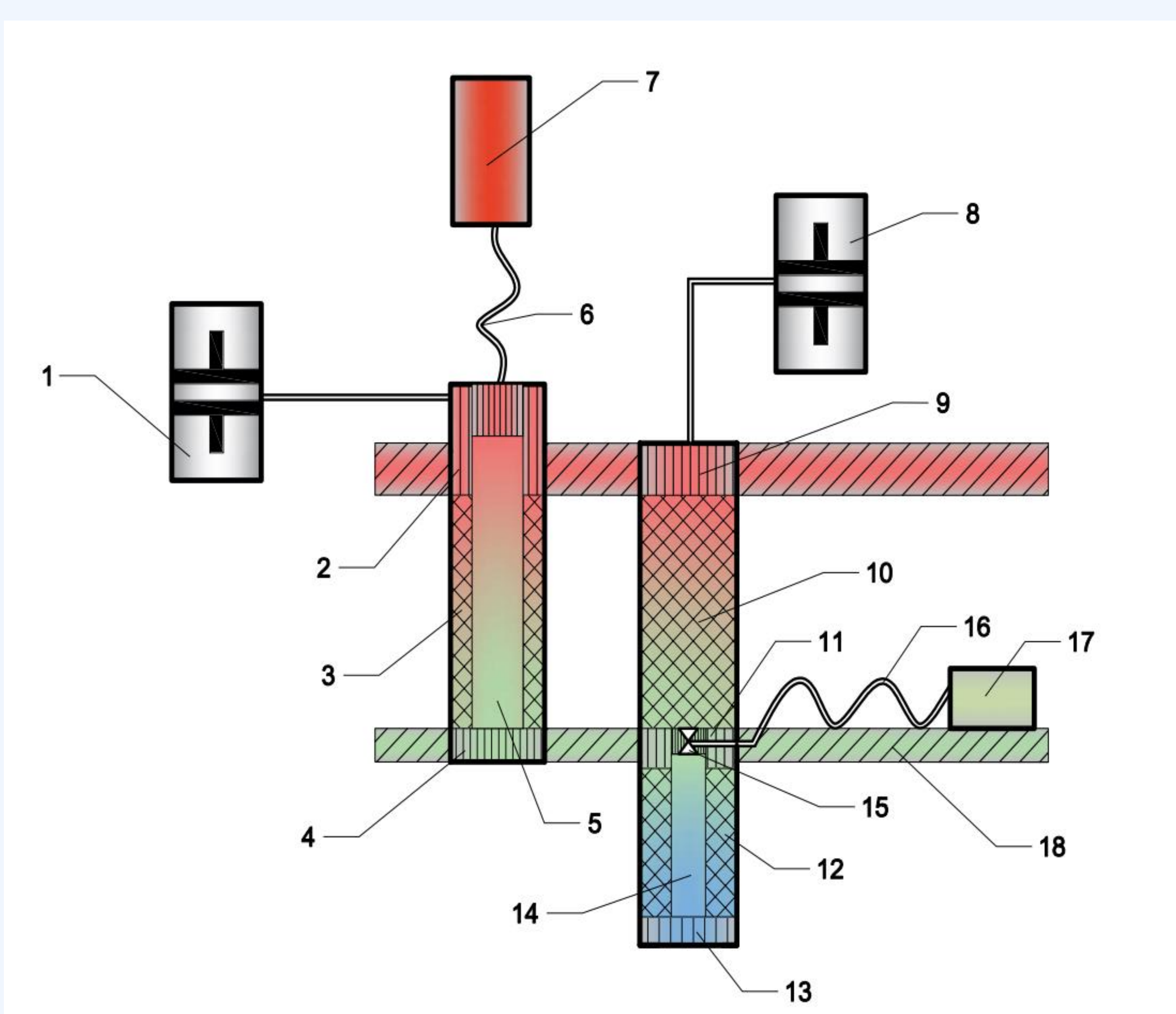
## Abstract

In order to increase the cooling power of the two-stage thermal-coupled pulse tube cryocooler working in the 20K temperature zone, the regenerative material was optimized in this paper. Stainless-steel screen, Er-plated stainless-steel screen and pressed Er-plated stainless-steel screen were used as the regenerative materials. The parameters and the experiment results of these kinds of materials were compared.




1. First stage compressor, 2. First stage hot end heat exchanger, 3. First stage regenerator, 4. First stage cold end heat exchanger, 5. First stage pulse tube, 6. First stage inertial tube, 7. First stage buffer, 8. Second stage compressor, 9. Second stage 300K heat exchanger, 10. Pre-regenerator, 11. Second stage 80K heat exchanger, 12. Second stage regenerator, 13. Second stage cold end heat exchanger, 14. Second stage pulse tube, 15. double-inlet valve, 16. Second stage inertial tube, 17. Second stage buffer

**Figure 1.** The structure of the two-stage thermal coupled pulse tube cryocooler.

## Regeneration Materials Parameters Analysis

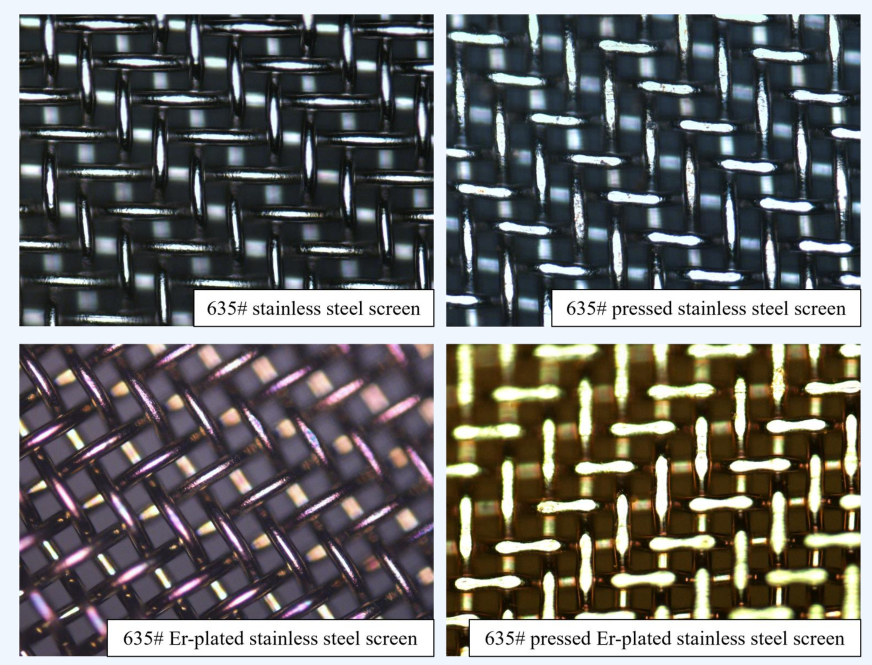



**Figure 2**. The picture of different kinds of screens under high power microscope.

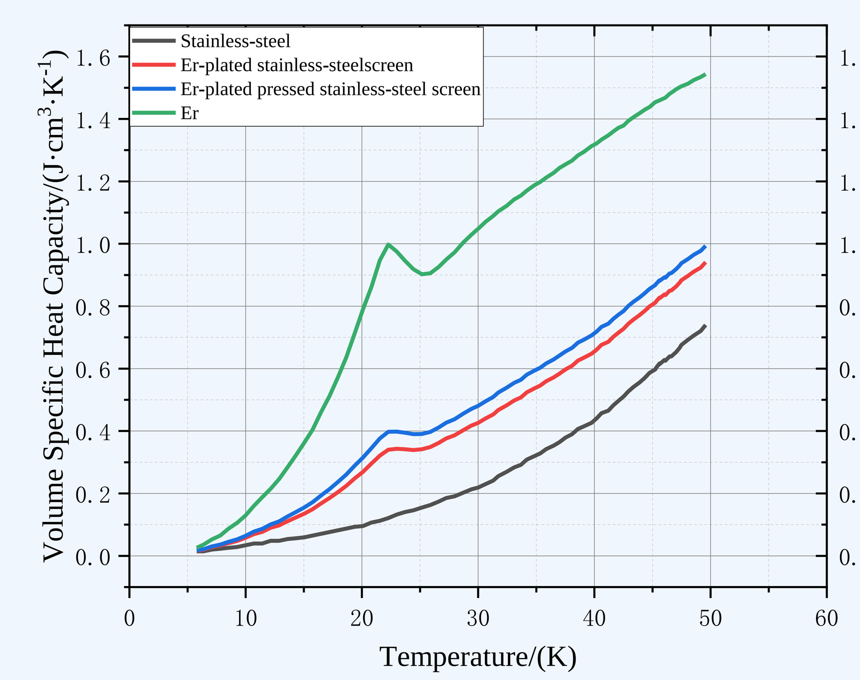



**Figure 3.** The volume specific heat capacity of different kinds of screens.

- The process of platting erbium or pressing the screen will make the porosity of the screen decrease and cause the resistance loss in the regenerator.
- The thermal conductivity of Er-plated screen is larger, which will cause axial heat conduction loss, so the plating thickness of the erbium is limited.
- Pressed Er-plated stainless-steel screen have larger volume specific heat capacity.

## Experiments Results And Discussion

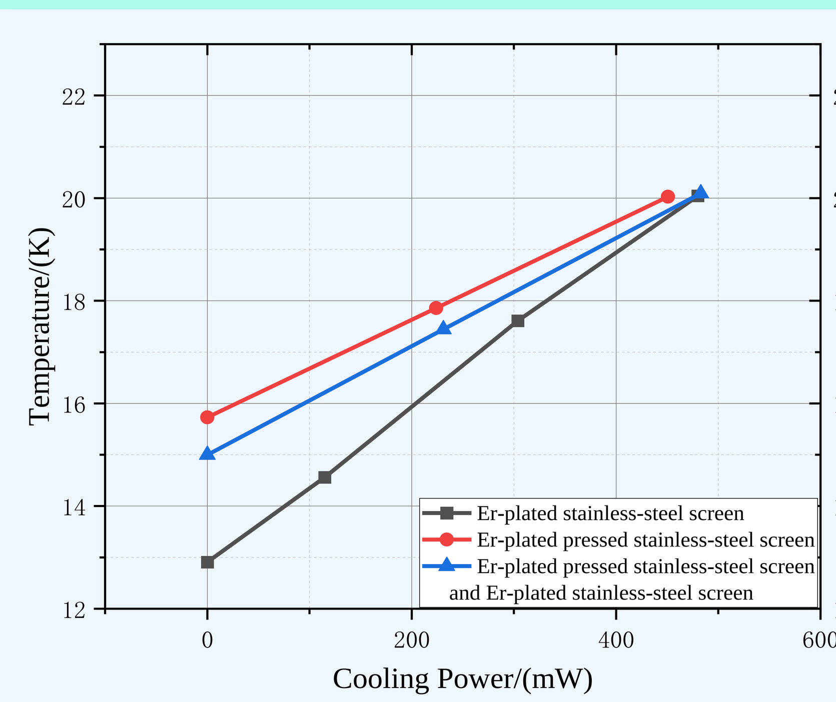



**Figure 4.** The temperature of the cold end changing with the cooling power with 100 W input power in the second stage

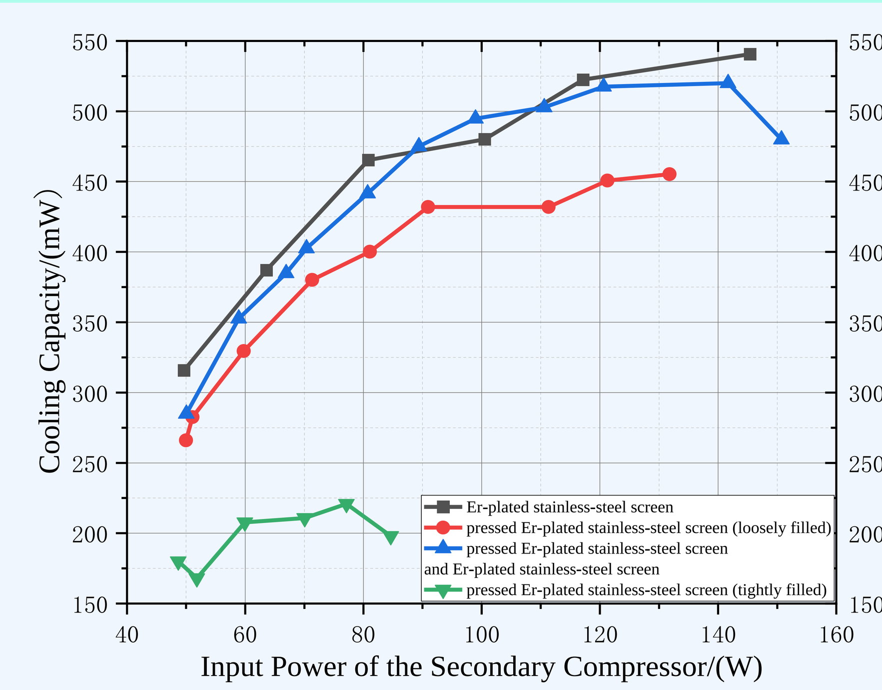



**Figure 5.** The cooling power of different kinds of regeneration materials at 20 K changing with the input power of the Second stage compressor.

- The cooling performance of the cold finger tightly filled with the pressed plated Er-plated stainless steel is worse. The reason is that the smaller porosity will increase the resistance and pressure drop, decrease the PV power input in the regenerator.
- Larger cooling power was obtained with half of the pressed Er-plated stainless-steel screen being replaced by the Er-plated stainless-steel screen, which is because the loss in the regenerator caused by resistance decreased.
- With 140 W input power in the first stage and 145 W input power in the second stage, a cooling power of 540 mW @ 20 K was obtained.

## Conclusion

This paper compares different kinds of screens used as the regeneration materials of the two-stage pulse tube cryocooler. The experiments results shows that the regenerator filled with pressed Er-pated stainless-steel screen can obtain larger volume specific capacity and has great potential of being a new type of regeneration material and the loosely filling way is suggested to avoid the increase of resistance.

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