Constraints of 4 supported seats on the bottom plate were fixed constraint, the vertical downward force applied on bottom plate, applied pressure on the base plate and partition respectively. The stress cloud chart and displacement cloud chart of this computing are shown in Figs. 4 and 5. The deformation ratio in the two figures was 1272. Figure 4 shows the maximum stress of the detector applied on the base plate and conformed to the reality. The maximum stress value was 1.178 MPa. Compared to the yield strength, the minimum safety coefficient is n = 27.57/1.178 = 23.404. Figure 5 shows that the maximum displacement of 0.025 mm was extremely small. A large margin existed in the safety coefficient and displacement, which is waste in the design. It is necessary to optimize this framework in the strength and stiffness of the structure by reducing the structure mass and saving materials under the premise of safety and reliance.

IV. OPTIMAL DESIGN OF PORTABLE OPTICAL FIBER SPR FOOD DETECTOR

The simulation integrated optimization module SimulationXpress was used to optimize the structure. The design principle was to reduce the mass of detector as much as possible under the premise of strong strength, rigidity and stability. The bottom plate and partition had large stress and deformation parameters to modify in order to implement this optimization. The overall dimensional parameter of the detector was maintained in order to avoid significant change in the system's structure.

The optimized thickness of the base plate(x1) and the partition(x2) were set to be 2.5 mm and the optimized safety coefficient was set to be 10.0 respectively. It should be noted that default optimization range in the module SimulationXpress might cause error due to model geometric conditions. As a result, optimal value was obtained after 20 times of simulation. The data related to this optimization is shown in Table 2. The strength and rigidity of optimized model was re-finite element analysis and its strength and rigidity were improved. Its mass was decreased from 4.298 kg to 3.916 kg, which indicated that the optimization process could reduce the structural mass and save materials.

V. CONCLUSION

SolidWorks was used to establish three-dimension model of the portable optical fiber SPR food detector. Simplification and optimization of this model was implemented by using SimulationXpress tools where the applied loads and constraints on this device were considered. The structure of detector was optimized in accordance with the requirements of stabilizing its framework. The reduction of its mass and improvement of safety coefficient were achieved by optimized the device' structure to maintain its stability and portability.

TABLE2. DATA BEFORE AND AFTER OPTIMIZATION

	Design variables		**Constraint condition**		
	x1(mm)	x2(mm)	maximum stress(MPa)	maximum displacement(mm)	Mass of detector(kg)
Original data	4.0	3.0	1.178	0.025	4.298
Optimized data	3.2	2.5	2.740	0.073	3.916

REFERENCES

[1] Rajan, Subhash Chand, B.D. Gupta, "Surface Plasmon resonance based fiber-optic sensor for the detection of pesticide," Sensors and Actuators B, vol.123, pp. 661-666, 2007.

[2] Simona Scarano, Marco Mascini, Anthony P.F. Turner, Maria Minunni, "Surface plasmon resonance imaging for affinity-based biosensors," Biosensors and Bioelectronics, vol.25, pp.957–966, January 2010.

[3] Barbora Špačková, Marek Piliarika, Pavel Kvasnička, Christos Themistos, Muttukrishnan Rajarajan, JiříHomola , "Novel concept of multi-channel fiber optic surface plasmon resonance sensor," Sensors and ActuatorsB, vol. 139, pp. 199–203, May 2009.

[4] Yinquan Yuan, Liyun Ding, Zhenqiang Guo, "Numerical investigation for SPR-based optical fiber sensor," Sensors and Actuators B, vol. 157, pp. 240-245,2011.

[5] Rajneesh K. Verma and Banshi D. Gupta, "Surface plasmon resonance based fiber optic sensor for the IR region using a conducting metal oxide film," JOSA A, vol. 27, pp. 846-851, 2010.

[6] Anuj K. Sharma, Rajan Jha, and B. D. Gupta,"Fiber-Optic Sensors Based on Surface Plasmon Resonance," A Comprehensive Review, IEEE Sensors Journal, vol. 7, pp. 1118-1129, 2007.

[7] Yin-quanYuan, Zhen-qiangGuo and Li-yun Ding, "Influence of metal layer on the transmitted spectra of SPR-based optical fiber sensor," OPTOELECTRONICS LETTERS, vol. 6, pp. 346-349, 2010.

[8] Yu-Cheng Lin, Woo-Hu Tsai, Yu-Chia Tsao, and Jiu-Kai Tai, "An Enhanced Optical Multimode Fiber Sensor Based on Surface Plasmon Resonance With Cascaded Structure," IEEE Photonics technology letters, vol. 20, pp. 1287-1289,2008.

[9] Godfrey Onwubolu, "Computer Aided Engineering Design With Solidworks," Imperial College Press London, UK, 2011 .

[10] Ping Hai-Tao, Wu Zhi-Lin, Mo Gen-Lin, "Improvement Measures and Application of Parametric Design of Machine Parts Based on SolidWorks API," Coal Mine Machinery, vol. 32, pp. 235-238, Jan 2011.

[11] L. Ertl and P. Houška, "Design of Mass Spectrometer Control in NI LabVIEW and SolidWorks,"MECHATRONICS, Part II, pp.197-202,2012.

[12] Hong YanXing, Yan BinZhang, Wu YangHuang, "Design and Simulation of Drum Solid-State Fermentation Equipment Based on Solidworks," Advanced Materials Research, vol.476, pp.438-442, February 2012.

[13] F. Wei, F.R. Wang, "3D Parametric Design for Steel Head frame of Coal Mine Based on Solidworks," Key Engineering Materials, vol. 455, pp. 340-344, December 2010.

[14] Tang Xin, Deng Yuanchao, "Model Analysis of Solid Carbide Taps Based on ANSYS Workbench and Solidworks," Tool Engineering. Vol. 45, pp. 33-34, April 2011.

[15] Liu Jiao, Li Hong-Bin,Qian Lina,Ni Fu-Sheng,Xu, "Wei-Guang,Finite Element Analysis of a Dredger Cutterhead Based on SolidWorks and ANSYS ," Machine Design and Research, vol. 26, pp. 64-66, May 2010.